Regional Operational Plan SF.1J.2014.14

# Production and Harvest of Chilkat River Chinook and Coho Salmon, 2014–2015

by

Brian W. Elliott,

Richard S. Chapell,

and

Sarah J. H. Power

October 2014

Alaska Department of Fish and Game Divisions of Sport Fish and Commercial Fisheries

# Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

**Weights and measures (metric)**

| | |
|---|---|
| centimeter | cm |
| deciliter | dL |
| gram | g |
| hectare | ha |
| kilogram | kg |
| kilometer | km |
| liter | L |
| meter | m |
| milliliter | mL |
| millimeter | mm |

**Weights and measures (English)**

| | |
|---|---|
| cubic feet per second | $ft^3/s$ |
| foot | ft |
| gallon | gal |
| inch | in |
| mile | mi |
| nautical mile | nmi |
| ounce | oz |
| pound | lb |
| quart | qt |
| yard | yd |

**Time and temperature**

| | |
|---|---|
| day | d |
| degrees Celsius | °C |
| degrees Fahrenheit | °F |
| degrees kelvin | K |
| hour | h |
| minute | min |
| second | s |

**Physics and chemistry**

| | |
|---|---|
| all atomic symbols | |
| alternating current | AC |
| ampere | A |
| calorie | cal |
| direct current | DC |
| hertz | Hz |
| horsepower | hp |
| hydrogen ion activity (negative log of) | pH |
| parts per million | ppm |
| parts per thousand | ppt, ‰ |
| volts | V |
| watts | W |

**General**

| | |
|---|---|
| Alaska Administrative Code | AAC |
| all commonly accepted abbreviations | e.g., Mr., Mrs., AM, PM, etc. |
| all commonly accepted professional titles | e.g., Dr., Ph.D., R.N., etc. |
| at | @ |
| compass directions: | |
| east | E |
| north | N |
| south | S |
| west | W |
| copyright | © |
| corporate suffixes: | |
| Company | Co. |
| Corporation | Corp. |
| Incorporated | Inc. |
| Limited | Ltd. |
| District of Columbia | D.C. |
| et alii (and others) | et al. |
| et cetera (and so forth) | etc. |
| exempli gratia (for example) | e.g. |
| Federal Information Code | FIC |
| id est (that is) | i.e. |
| latitude or longitude | lat or long |
| monetary symbols (U.S.) | $, ¢ |
| months (tables and figures): first three letters | Jan,...,Dec |
| registered trademark | ® |
| trademark | ™ |
| United States (adjective) | U.S. |
| United States of America (noun) | USA |
| U.S.C. | United States Code |
| U.S. state | use two-letter abbreviations (e.g., AK, WA) |

**Mathematics, statistics**

| | |
|---|---|
| *all standard mathematical signs, symbols and abbreviations* | |
| alternate hypothesis | $H_A$ |
| base of natural logarithm | *e* |
| catch per unit effort | CPUE |
| coefficient of variation | CV |
| common test statistics | (F, t, $\chi^2$, etc.) |
| confidence interval | CI |
| correlation coefficient (multiple) | R |
| correlation coefficient (simple) | r |
| covariance | cov |
| degree (angular ) | ° |
| degrees of freedom | df |
| expected value | *E* |
| greater than | > |
| greater than or equal to | ≥ |
| harvest per unit effort | HPUE |
| less than | < |
| less than or equal to | ≤ |
| logarithm (natural) | ln |
| logarithm (base 10) | log |
| logarithm (specify base) | $\log_{2,}$ etc. |
| minute (angular) | ' |
| not significant | NS |
| null hypothesis | $H_O$ |
| percent | % |
| probability | P |
| probability of a type I error (rejection of the null hypothesis when true) | $\alpha$ |
| probability of a type II error (acceptance of the null hypothesis when false) | $\beta$ |
| second (angular) | " |
| standard deviation | SD |
| standard error | SE |
| variance | |
| population | Var |
| sample | var |

# *REGIONAL OPERATIONAL PLAN SF1J.2014.14*

## PRODUCTION AND HARVEST OF CHILKAT RIVER CHINOOK AND COHO SALMON, 2014–2015

by

Brian W. Elliott, Richard S. Chapell

Alaska Department of Fish and Game, Sport Fish Division, Haines

and

Sarah J. H. Power

Alaska Department of Fish and Game, Sport Fish Division, Juneau

Alaska Department of Fish and Game
Division of Sport Fish
Regional Address

October 2014

*Brian W. Elliott and Richard S. Chapell*
*Alaska Department of Fish and Game, Division of Sport Fish,*
*PO Box 330, Haines, AK 99827*

*and*

*Sarah J. H. Power*
*Alaska Department of Fish and Game, Division of Sport Fish,*
*1255 W. 8th Street, Juneau AK 99802*

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**Approval**

| Title | Name | Signature | Date |
|---|---|---|---|
| Project Leader | Brian W. Elliott | | 8.14.2014 |
| Area Management Biologist | Richard Chapell | | 8/15/2014 |
| Biometrician | Sarah Power | | 8-14-14 |
| Research Coordinator | Jeff Nichols | | 9-11-14 |
| Regional Supervisor | Brian Frenette | | 9.16.14 |

**Chinook Salmon Research Initiative Approval**

| Title | Name | Signature | Date |
|---|---|---|---|
| Fish and Game Coordinator | Ed Jones | | 8.14.14 |
| Fisheries Scientist | James Hasbrouck | | 8/26/2014 |
| Fisheries Scientist | Eric Volk | | 9/11/2014 |

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# ABSTRACT

An ongoing coded-wire tag (CWT) project, used as part of a stock assessment program for Chilkat River Chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*Oncorhynchus kisutch*), will be conducted during fall 2014 and spring 2015 to provide estimates of smolt abundance and marine harvest for Chinook salmon, and smolt abundance, marine harvest, mark fraction, and age composition of coho salmon. The CWT project uses modified Peterson 2-event mark-recapture methods to estimate smolt abundance, and port and creel sampling of CWTs in mixed stock commercial and sport fisheries provides data to estimate marine harvest for both species. Juvenile salmon will be marked with adipose fin clips and a CWT in fall 2014 (Chinook salmon parr) and spring 2015 (Chinook and coho salmon smolt) as event 1 of the mark-recapture study. During event 2, adult Chinook and coho salmon will be sampled for missing adipose fins, CWTs, and age, sex, and length (ASL) in the Chilkat River fishwheels, operated in the lower Chilkat River. Adult Chinook salmon will be also sampled for missing adipose fins, CWTs, and ASL on Chilkat River drainage spawning grounds to complete event 2 sampling. Age composition of coho salmon smolt and adults will be estimated by scale aging techniques. The Alaska Department of Fish and Game uses these data to make local and regional management decisions. Chilkat Chinook salmon is a Pacific Salmon Commission (PSC) indicator stock and has recently been added to the base model of abundance indicator stocks for the Chinook Technical Committee (CTC), which influences coastwide management.

Key words: Chinook salmon, coho salmon, coded wire tag, mark-recapture, escapement, Chilkat River, Haines, Lynn Canal, marine harvest, marine survival.

# PURPOSE

The Chilkat River is considered the third or fourth largest producer of Chinook salmon in Southeast Alaska (McPherson et al. 2003). Chilkat River Chinook salmon is a Pacific Salmon Commission (PSC) indicator stock and contributes towards management of the Southeast Alaska sport fishery allocation in accordance with the Pacific Salmon Treaty (PST). The Chilkat River is also the second largest producer of coho salmon (Shaul et al. 2008), and provides the majority of the coho salmon freshwater fishery in the Haines area, which is one of the largest freshwater fisheries in Southeast Alaska (Jennings et al. 2011).

Stock assessment of Chilkat River Chinook and coho salmon produces full production data; the Chilkat River coded wire tag (CWT) project is an important component towards estimating smolt abundance, marine harvest in mixed-stock fisheries, and marine survival from smolt to adult. Coded wire tag studies have been conducted on the Chilkat River consistently since 1999. Smolt abundance along with harvest contributions have been estimated for Chilkat River Chinook salmon brood years 1998–2006, with brood years 2007–2011 in progress. Smolt abundance, marine harvest, and marine survival have been estimated for coho salmon outmigration years 1999–2011, with 2012 and 2013 in progress.

Chilkat River Chinook salmon smolt abundance averaged 175,015 (SE = 39,768) for brood years (BY) 1999–2006, total return averaged 4,583 (SE = 563), marine harvest averaged 879 (SE = 221), and marine survival averaged 3.0% (SE = 0.7%). For emigration years 1999–2012, Chilkat River coho salmon smolt abundance averaged 1,286,773 (SE = 253,223), total return averaged 136,918 (SE = 20,749), marine harvest averaged 57,270 (SE = 10,060), and marine survival averaged 10.3% (SE = 2.0%).

This operational plan includes the study design for fall coded-wire tagging of Chinook salmon parr on the Chilkat River (and Tahini and Kelsall River tributary systems) during September and October 2014, as well as spring tagging of Chinook and coho salmon smolt during April and May 2015 in the Chilkat River.

# BACKGROUND

The Chilkat River is a large glacial system that originates in British Columbia, Canada, flows through rugged dissected mountainous terrain, and terminates in Chilkat Inlet near the northern terminus of Lynn Canal (Figure 1). The main channels and major tributaries comprise approximately 350 km of fluvial habitat in a watershed covering about 1,600 km² (Bugliosi 1988). The Chilkat River is the third or fourth largest producer of Chinook salmon (*Oncorhynchus tshawytscha*) (McPherson et al. 2003) and the second largest producer of coho salmon (*O. kisutch*) in Southeast Alaska (Shaul et al. 2008) .

The spring marine boat fishery near Haines has harvested up to 1,700 Chinook salmon in the mid-80s and recently has averaged 257 Chinook salmon, many of which are Chilkat River spawners (Table 1). From 1981 through 1992, the Chilkat River Chinook salmon escapement was monitored through peak survey counts on clearwater tributaries to the Chilkat River (Big Boulder Creek and Stonehouse Creek) as an index of abundance. Mark-recapture (M-R) experiments have been used to estimate the abundance of large Chinook salmon entering the Chilkat River since 1991. Comparisons of 1991 and 1992 M-R estimates to expanded Stonehouse Creek and Big Boulder Creek index counts showed that the expanded index counts grossly underestimated total Chilkat River abundance (Johnson et al. 1993).

Between 1991 through 2013, M-R estimates of inriver abundance of large Chinook salmon have ranged from 1,442 to 8,100 fish (Table 2). In 2003, the department adopted an escapement goal range of 1,750–3,500 large Chinook salmon for the Chilkat River drainage, and the Chilkat River and Lynn Canal King Salmon Fishery Management Plan (5 AAC 33.384) specifies an inriver abundance goal range of 1,850–3,600 large Chinook salmon upstream of the adult marking area, based on stock-recruit analysis (Ericksen and McPherson 2004). Since Chilkat River Chinook salmon inriver M-R studies were begun in 1991, inriver run estimates were below the lower bound of the goal range in four years: 2007, 2010, 2012, and 2013 (Chapell 2010, 2013b, *in prep a,* Elliott and Chapell *in prep*).

Coded wire tag studies of Chilkat River Chinook salmon have been conducted since 1985, and consistently used from 1999 through 2013 (Table 3). Chinook harvest contributions have been estimated for the Tahini River BY's 1984 and 1985 (Johnson et al. 1993) and the Chilkat River BYs 1988, 1989, 1991, 1998, and 1999–2006 (Ericksen 1996, 1999; Ericksen and Chapell 2006b; Chapell 2009, 2010, 2012, 2013a-b, *in prep a-b*, Elliott and Chapell *in prep*). These studies indicate that Chilkat River Chinook salmon rear primarily in the inside marine waters of northern Southeast Alaska, and that exploitation rates on this stock have ranged from 8% to 27% (Table 4). However, a 1991 study that compared logbook-recorded catch rates to fish ticket-reported catches showed that the Chinook salmon harvest in the Lynn Canal commercial drift gill net fishery was grossly underreported, so marine exploitation rates may have been and continue to be substantially higher (Ericksen and Marshall 1997). Stock assessment data will also be continuously updated by including estimates of fall parr abundance, smolt abundance, overwinter survival, marine survival, and exploitation rates provided by CWT studies.

The Chilkat River produces most of the coho salmon harvested in Haines area recreational fisheries and supports one of the largest freshwater coho fisheries in the Southeast Alaska region, with an average annual harvest of 2,060 coho salmon from 2000 to 2009 (Jennings et al. 2004, 2006a-b, 2007, 2009; Walker et al. 2003; http://docushare.sf.adfg.state.ak.us/dsweb/View/Collection-222, accessed July 2011). The contribution of Chilkat River coho salmon to mixed stock commercial and sport fisheries is Southeast Alaska averaged 57,270 from 2000 to 2013 (Table 5). Escapement and harvest research conducted during the 1980's on coho salmon stocks in Lynn Canal suggest that these stocks were subjected to very high (> 85%) exploitation rates (Elliott and Kuntz 1988; Shaul et al. 1991).

Chilkat River coho salmon smolt were tagged with CWT's intermittently from 1976 to 1984, and annually from 1999 to 2014 (Table 6). A proportion of the 10,878 coho salmon smolt tagged in 2013 (Table 6) will start entering the lower Chilkat River as adults in August 2014, where a proportion will be captured and sampled for CWTs, which produces the smolt abundance estimate for the 2013 emigrating class. Overall, the Chilkat River coho salmon CWT project allows for estimates of smolt emigration abundance, marine harvest by fishery, total marine and fresh water exploitation, and smolt-to-adult survival (Table 5). Total marine harvest (commercial, sport, and subsistence fisheries) has ranged from 12,142 fish in 2007 to 128,466 fish in 2004. Most of the marine harvest occurs in the commercial troll fishery (54–68%) and the Lynn Canal drift gillnet fishery (26–54%). Marine exploitation has varied from 29% to 65% during 2000–2013 (Table 5). Commercial fishery management, weather conditions, and the price of coho salmon are the primary reasons for the fluctuation in marine exploitation.

The Chilkat River coho salmon total escapement, including ocean age-.0 fish, has been estimated each year since 1987 by expanding peak counts from index area foot surveys in four widely distributed streams: Spring Creek in the Tsirku River drainage, Kelsall River, Tahini River, and Clear Creek on the west side of Chilkat Inlet (Table 7, Figure 2). The total of all four index counts is expanded to estimate escapement, based on five past M-R experiments used to calibrate the index count. Mark-recapture projects were conducted in 1990 (estimate: 79,807 fish, SE = 9,980), 1998 (estimate: 50,758, SE = 10,698), 2002 (estimate: 205,429, SE = 31,165), 2003 (estimate: 134,340, SE = 15,070), and 2005 (estimate: 38,589, SE = 4,625) (Elliott 2009). Averaging the ratios of M-R estimates to the sum of concurrent peak index counts has produced an expansion factor of 33.6 (SE = 6.5). Mark-recapture studies must be repeated periodically to calibrate the expansion factor.

This operational plan covers sampling and estimation of smolt abundance and subsequent adult harvest by marking Chinook salmon parr with adipose fin clips and CWTs in fall 2014, and marking Chinook and coho salmon smolts in spring 2015.

# OBJECTIVES

1. Estimate the number of Chinook salmon smolt leaving the Chilkat River in spring 2015 such that the estimate is within 30% of the true value 90% of the time.

2. Estimate the marine harvest of Chilkat River Chinook salmon from the 2013 brood year (via recovery of adults with coded wire tags that emigrate as smolt in 2015) such that the estimate is within 35% of the true value 90% of the time.[1]
3. Estimate the number of coho salmon smolt leaving the Chilkat River in 2015, such that the estimate is within 40% of the true value 90% of the time.
4. Estimate the marine harvest of Chilkat River coho salmon in 2016 (via recovery of adults with coded wire tags that emigrate as smolt in 2015) such that the estimate is within 25% of the true value 90% of the time.[2]
5. Estimate the proportion of adult coho salmon returning to the Chilkat River in 2016 that were marked with coded wire tags in 2015, such that the estimate is within 5% of the true value 90% of the time..
6. Estimate the age composition of coho salmon smolt emigrating from the Chilkat River in 2015 such that the estimates are within 5% of the true values 90% of the time..
7. Estimate the age composition of adult coho salmon in the Chilkat River in 2016 such that the estimates are within 5% of the true values 90% of the time.

### SECONDARY OBJECTIVES

1. Estimate the abundance of Chinook salmon parr rearing in the Chilkat River in fall 2014.
2. Estimate the mean length of Chilkat River Chinook salmon parr (in fall 2014) and the mean length of smolt emigrating in spring 2015.
3. Estimate the mean length-at-age of coho salmon smolt emigrating from the Chilkat River in 2015.

# METHODS

Two-event M-R experiments will be used to estimate the abundance of Chilkat River Chinook salmon parr rearing in-river fall 2014, Chinook salmon smolt emigrating in spring 2015, and coho salmon smolt emigrating in spring 2015. Fish in M-R event 1 will be marked by removing the adipose fin and inserting a CWT in the nose cartilage. Marked fish will be sampled to estimate mean length and weight. Coho salmon smolt will be sampled to estimate freshwater age composition. For M-R event 2 sampling, adult Chinook and coho salmon will be sampled for missing adipose fins and CWT presence as they return to the Chilkat River in 2016 (coho salmon) and 2016–2020 (Chinook salmon). The harvest of Chinook and coho salmon will be estimated through the recovery of CWTs in randomly sampled fisheries.

Chilkat River Chinook salmon are almost all (>99%) from a single freshwater age, overwintering 1 year as parr and emigrateing as age-1. smolt (Olsen 1992). Therefore, Chinook salmon parr tagged in the fall of year $t$+1, and smolt tagged in the spring of year $t$+2, are from BY $t$. Adult Chinook salmon return to the river over a span of five years, beginning with age-1.1 "jacks" in year $t$+3 and ending with age-1.5 fish in year $t$+7. For example, Chinook salmon tagged with CWTs in the fall of 2014 (parr) and spring 2015 (smolt), both from BY 2013, will return in 2016 (age-1.1 "jacks") though 2020 (age-1.5 fish).

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[1] Estimate will be derived from tag recoveries in marine fisheries and the Chilkat River from 2016 through 2020.

[2] Estimate will be derived from tag recoveries in marine fisheries and the Chilkat River in 2016.

Coho salmon returning to the Chilkat River belong primarily to 2 age classes: age 1.1 (1998–2010 average 76%), and age 2.1 (1998–2010 average 22%). The remaining age classes are age-1.0 and age-2.0 “jacks” that have composed 3% of the escapement over the same time period. Because the majority of coho salmon are 1-ocean year rearing fish, coho smolt tagged with CWTs in 2015, from BYs 2012 and 2013, will return primarily in 2016 (ocean-age-1).

## SMOLT AND PARR TAGGING

### Fall 2014 - Chinook Salmon Parr Tagging

To estimate juvenile (parr) Chinook abundance, we will fish 80–100 baited minnow traps per day in the Tahini River, Kelsall River, and Chilkat River main channels from the Kelsall River confluence downstream to Haines Highway milepost (MP) 10. Captured fish will be sorted, and only juvenile Chinook salmon will be retained for tagging. All trapping locations will be recorded with global positioning system (GPS) coordinates and juvenile Chinook salmon catches will be recorded by location. All Chinook salmon parr caught in traps will be transported to a central tagging location. Once at the tagging site, all healthy Chinook salmon parr ≥50 mm fork length (FL) will have their adipose fin removed and will be tagged with a 1.1 mm CWT (see Data Collection for details of processing). All Chinook salmon tagged will be checked the day after tagging for tag retention and released in the same stream as captured. One code of 10,000 tags will be used until exhausted; additional codes will be used for every subsequent 10,000 fish tagged during the fall project.

The Tahini and Kelsall river trapping areas align closely with results of 1991, 1992, and 2005 radio telemetry studies (Johnson et al. 1992, 1993; Ericksen and Chapell 2006b), which indicated that 85–92% of the Chinook salmon entering the Chilkat River spawn in these two drainages.

Tagging operations will begin September 16 on the Tahini River, where a crew of four technicians will trap and tag juvenile Chinook salmon for up to 10 days, depending on river conditions and catch rates. If catch rates are lower than expected in traditional trapping areas, traps will be set over a wider area in an exploratory fashion to locate concentrations of rearing fish. In efforts to maximize catch rates, traps will be moved consistently when catch rates drop.

The Kelsall River has been the biggest producer of juvenile Chinook salmon in most years (Table 3) and will continue to be the major focus of effort in fall 2014. Trapping efforts on the Kelsall River will commence October 1 and will continue for up to 14 days, or until all trapping areas are exhausted.

After leaving the Kelsall River, trapping efforts will move to Chilkat River main channels. Traps will be set primarily between MP 13 and MP 19, and in the section between MP 24 and the Kelsall River confluence. The Chilkat River portion of the project does not require a field camp, as the crew is based from the Haines office.

### Spring 2015 - Chinook and Coho Smolt Tagging

From April 3 through May 13, 2015, a minimum of 80 and up to 100 baited minnow traps will be fished daily in main channels of the lower Chilkat River, MP 10–21, in an effort to maximize Chinook salmon smolt catches. All coho salmon smolt captured in the process will also be tagged. Gear will be set in Chinook salmon habitat sites that provide the best chance of capturing a representative sample of smolt from several tributaries of the Chilkat River. Global positioning system coordinates and Chinook and coho salmon smolt catches will be recorded at each tagging site. Two trap lines will be checked at least once per day by two teams of 2 technicians each. If time permits, traps that produced the greatest catches during the first check will be checked twice. Short (40') beach seines will also be used concurrently with minnow traps to capture additional Chinook salmon smolt.

Compared to spring CWT efforts in years 2001–2012, the spring 2015 effort will be shorter in duration but similar to 2013 and 2014. We will utilize a minimum of 41 trapping days, beginning in early April and running until mid-May. The expected number of valid CWTs released is based on a conservative daily trap total (80 traps, Appendix A1). The estimated number of Chinook salmon smolt based on 2013-2014 CPUE is 4,531 fish, and estimated coho salmon smolt marked is 9,585. Only the most recent CPUE is used because of the shift in project focus and duration compared to 2000-2012. Average Chinook salmon CPUE in 2013-2014 was 1.4 fish per trap, and average coho salmon CPUE was 3.0 fish per trap.

All target species caught in traps will be transported to a central tagging location. Every second day, depending on the number of smolts caught, collected fish will be sorted by species and size. All healthy Chinook ≥50 mm and coho ≥75 mm FL captured will be adipose finclipped and tagged in the snout with a 1.1 mm CWT (see Data Collection for details of processing). Tagging every second day will increase capture rates by allowing for more time to seek out productive trapping areas. A Northwest Marine Technology Mark IV[3] tag injector will be dedicated to tagging Chinook salmon with a unique code. Spools of coded wire will be changed only when exhausted.

Coho salmon smolt will be sorted into 3 size categories: small (≥75 mm and <85 mm), medium (≥85 and <100 mm), and large (≥100 mm). A tag injector will be dedicated to tagging coho salmon. A different size head mold (small, medium, large) will be used with each size group to achieve optimal CWT placement and retention. Two unique tag codes will be assigned by size: small fish will receive one code, and medium and large fish (all coho salmon ≥85 mm) will receive the other code. Tagging each size group (small vs. medium/large) of coho salmon smolt with unique tag codes will allow for detection of differential recovery rates as adults. An alternate smolt population estimator discussed in Data Analysis can eliminate bias created in disproportionate tagging of coho salmon smolt.

## Sampling Adult Coho and Chinook Salmon to Estimate Smolt and Parr Abundance

Division of Commercial Fisheries (CF) personnel will capture adult coho salmon in two fish wheels along the Chilkat River, adjacent to the Haines Highway between MP 7 and 9, operated annually from approximately June 10 to October 15. Data collected in previous years indicates that 97% of the immigrating coho salmon will be caught during this time period. Fish wheels will operate continuously except when stopped for maintenance.

Proportional sampling of coho salmon in the lower Chilkat River fish wheels (Figure 2) will produce the marked fraction estimate used to calculate smolt abundance and adult harvest. In 2014, we expect the return of coho salmon that emigrated in spring 2013, when 10,878 fish were marked with CWTs and released. It is very important that all coho salmon are inspected for

[3] Northwest Marine Technology, 976 Ben Nevis Loop, Shaw Island, WA, 98286

missing adipose fins. Coho salmon will be carefully removed from the fish wheel holding pen, and placed into a trough filled with water. All newly captured coho salmon will be sampled for length from mid eye to fork of tail (MEF), sex, and missing adipose fins. All data will be recorded on the Alaska Department of Fish and Game (ADF&G) Adult Salmon Age-Length form version 3.0 (ASAL, Figures 3 and 4). Fish that are missing their adipose fins will be sacrificed for recovery of the CWT. Heads will be removed and marked with a numbered plastic cinch strap; the strap number will be recorded on the ASAL form and a CWT recovery form. To prevent double sampling, all coho salmon captured in the lower river will be given a lower left operculum punch that will be recognized upon recapture.

To systematically subsample the coho salmon immigration for age composition, scales will be collected at a rate of approximately 1 out of 3 fish, and in addition, from all fish with missing adipose fins. The first 13 of 40 fish, regardless of adipose fin clip status, will be recorded on an ASAL labeled *001* (Figure 3). The associated scale cards will be numbered sequentially, with the first 10 scales on card *001*, and the remaining 3 scale samples, plus any additional scales from adipose-finclipped fish, on card *002*. The fish numbered 14 or higher (CWT fish only) will not be used for calculating age composition, but for determination of recovery rates and freshwater ages of the 2 different coho salmon smolt tagging groups. The remaining 27 out of 40 fish will be sampled for sex and length only, and their data will be recorded on ASAL form labeled *002A* (Figure 4). For subsequent batches of up to 40 fish, the first 13 fish will again be sampled for sex, length and scales, their scales placed on cards *003* and *004*, and their ASAL form labeled *004*. The data (sex and length only) for the remaining 27 of 40 fish will be recorded on ASAL form *004A*. Each new sampling day will start with a new set of ASAL forms scale cards, with numbering continued sequentially. This numbering system will assist CF staff in entering the sex, length, and age data into the CF database.

The scale sampling procedure includes removing 5 scales from the left side of each sampled fish (right side if left-side scales are regenerated) along a line 2 to 4 scale rows above the lateral line between the posterior insertion of the dorsal fin and anterior insertion of the anal fin (Scarnecchia 1979). Scales will be carefully cleaned and placed on gum cards at the rate of one fish per column (i.e., scales from fish #1 will be placed over 1, 11, 21, and 31 on the gum card, and the fifth scale will be placed in the blank space just below 31). Scales need to be upright (posterior down) with the rough (convex) side out. Obvious regenerated scales will be discarded and new scales selected. When placing scales, room will be left at the top middle portion of the card so a label can be affixed later. Scale cards will be kept as dry as possible to prevent gum from running and obscuring the scale ridges, and will be completely labeled including the last names of each sampler. A triacetate impression of the scales (30 seconds at 3,500 lb/in$^2$, at a temperature of 97°C) will be used for age determination. Scales will be read for age using protocols in Mosher (1969) and the CF scale-aging group.

Escapement sampling of adult Chinook salmon in the Chilkat River is detailed in a separate operational plan covering the use of fish wheels and drift gillnets in the lower river and various gear types on the spawning grounds to capture adults (Elliott et al. 2014). The details relevant to the objectives of this plan are as follows: all adult Chinook salmon captured in the lower river and on the spawning grounds will be inspected for missing adipose fins and sampled for age, sex, and length. Heads will be collected (for CWTs) from Chinook salmon less than 660 mm MEF (primarily age-1.1 and-1.2 males). Heads will also be taken from fish that show a negative wand detector result for a head CWT to confirm the head CWT loss rate. Heads will also be taken from spawned-out fish and carcasses of all sizes on the spawning grounds (61% of the large fish sampled in 1991–2013). These criteria for sacrificing fish will minimize the impact of sampling on Chinook salmon spawning production.

## SAMPLE SIZES

### Smolt and Parr Abundance

#### *Chinook Salmon*

Returning Chinook salmon in the Chilkat River will be inspected for marks (missing adipose fins) in 2016 through 2020 (ages 1.1 to 1.5) during annual adult M-R studies, as detailed in Elliott et al. (2014). Lower Chilkat River capture gear includes drift gillnets operated by Division of Sport Fish (SF) and the fish wheels operated by CF. Spawning Chinook salmon will also be inspected in several spawning locations using various capture gear types. Inriver abundance of ocean-age-2 and older Chinook salmon in recent brood years (1999–2006) has averaged 3,704 fish (SE = 509; Table 4). The harvest rate of Chilkat River Chinook salmon has averaged 19.2% (SE = 4.3%) under recent fishing regulations (BY 1999–2006), which totaled 879 fish per year in all marine fisheries, including commercial, sport, and subsistence (Appendix A2). Assuming average smolt abundance, we anticipate 175,015 Chinook salmon smolt will leave the Chilkat River in 2015. Assuming average overwinter survival (36.1%, Table 4), we anticipate that 502,352 Chinook salmon parr will be rearing in the Chilkat River drainage during the fall of 2014. If the tagging goal of 25,000 Chinook salmon parr is reached in fall 2014, 5.0% of the parr population will be marked. This 25,000 parr goal has been met in 9 of the last 14 years (2000–2013, Table 3), so the goal is likely to be attained. Approximately 9,025 (36.1% x 25,000) of these marked parr should survive to emigrate as smolt. Using anticipated spring CPUE from 2013-2014 (Appendix A1), an additional 4,531 Chinook salmon smolt will be marked in spring 2015, so we can reasonably expect 13,556 from an average smolt population of 175,015 to be marked with CWTs (marked fraction 7.7%, Appendix A2).

From 1994 to 2013, an average of 795 adult Chinook salmon (208 in the lower river and 587 on spawning grounds) have been inspected annually for missing adipose fins. In efforts to conserve the small stock, not all fish missing adipose fins will be sacrificed to recover CWTs (Objectives 1 and 2). Heads will be taken only from fish <660 mm MEF and from post spawners and carcasses, so samples sizes for a BY are expected to be 152 "jacks" (average number of fish <660mm MEF sampled for adipose fin clips, 1994–2013) and 341 adults (average number of post spawners or carcasses ≥660mm MEF sampled for adipose fin clips, 1994–2013), or 494 valid samples. Because an escapement sample of 390 fish is needed to meet the criteria for Objective 1 (Robson and Regier (1964), smolt emigration of 175,015 with 13,556 marked, no lost CWTs; alpha = 0.10; d = 0.30), meeting the criteria in Objective 1 seems reasonable.

#### *Coho salmon*

Using 2013-2014 CPUE and the minimum of traps deployed for 41 days of trapping (April 3–May 13, Appendix A1), 9,585 coho salmon smolt will be coded-wire tagged and released in 2015. Under the current study design, therefore, it is unlikely that the number of coho salmon smolt tagged and released will meet or exceed the 2001–2014 average of 22,189 fish (Table 6).

Returning adult coho salmon will be inspected for missing adipose fins in 2016 in Chilkat River fish wheels operated by CF. The fraction used to estimate smolt abundance is the proportion of 1-ocean coho salmon missing adipose fins ($\theta_{smolt}$). We anticipate capturing and sampling about 2,351 returning 1-ocean coho salmon in the fish wheels (average number inspected 2000–2013). Assuming the fraction of tagged smolt ($\theta_{smolt}$) is 0.021 (average from return years 2000–2013), then 46 of the 2,426 sampled fish should be missing adipose fins. Using the model of Robson and Regier (1964) with an assumed population size of 1,286,773 (Table 5) and 9,585 marks released, a sample of 2,707 adults is needed to meet criteria (±40% for a 90% confidence interval, Objective 3, assuming alpha = 0.10, d = 0.40). Because of reduced tagging levels of Chilkat coho salmon, it is possible the Objective 3 criteria may not be met. It is very possible, however, that the fish wheel catch could exceed the 2000-2013 average, which would boost the sample size and meet the criteria. Our field sampling design has resulted in meeting the ±40% level of precision in all 14 outmigration years 1999–2012 (Table 5); the goal remains to mark and inspect as many fish as possible.

## AGE COMPOSITION, MEAN LENGTH, AND MARKED FRACTION

The age composition, mean length-at-age, and marked fraction of immigrating Chinook salmon in 2016–2020 will be estimated as detailed in a separate operational plan for the annual SF adult stock assessment project (Elliott et al. 2014).

Age composition and mean length-at-age of immigrating coho salmon will be estimated from a systematically drawn sample of the fish caught in the fish wheels. Based on procedures in Thompson (2002) for a 4-age-class population and an average estimated escapement of 76,758, with alpha = 0.10 and d = 0.05, 448 samples are needed. In an exercise to numerically demonstrate how sample sizes are derived, the proportions representing 1.0- and 2.0-age fish were constrained at historical proportions of 0.03 and 0.01, respectively, and the highest variability scenario when proportions between age 1.1 and 2.1 coho salmon are almost equal, was investigated (Figure 5). This model, based on Thompson (2002), produces a sample size maximum that, when data loss is accounted for, is commensurate with the required sample size (461) for a multinomial estimation with the given precision criteria.

Because on average 90% of adult scale samples are readable, the maximum required sample size is 448 (d = 0.05, alpha = 0.10, $n$ = 76,758, data loss = 10%). The average fish wheel catch of 1-ocean coho salmon from 2000 to 2013 is 2,351 fish. To ensure that this sample goal is met, <u>every third fish caught (2,351/3 = 784) will be sampled for scales</u>. Fish wheel catches have shown considerable variability from year to year; even though the projected number sampled greatly exceeds the requirement, in low catch years sampling every third fish should come close to meeting the goal. Since coho salmon sampling was started in the Chilkat River, the lowest proportion of age-1.1 fish has been around 0.70, requiring fewer than 448 samples to meet Objective 7. As a result, 784 fish sampled should be ample to meet Objective 7 criteria. Objective 5 criteria will also be achieved, based on procedures in Thompson (2002), because only 34 fish are required to estimate a binomial proportion to within 0.05 of the true value 90% of the time (d = 0.05, alpha = 0.10, p = 0.030 (the highest theta for this project since 2000), $n$ = 76,758, data loss = 10%). The estimates should be unbiased because, even if the sampling gear is size selective, the differences in age composition for coho salmon in Southeast Alaska are exclusively differences in freshwater age (except for a small number of "jacks"), and there is no relationship between freshwater age and the size of adult coho salmon.

Age composition of coho salmon smolt will be estimated from a systematically drawn sample of fish caught in the minnow traps. Based on the procedures in Thompson (2002), 285 samples are necessary to estimate binomial proportions (d = 0.05, alpha = 0.10, p = 0.5, N = 1,286,773, data loss = 5%) and satisfy Objective 6 criteria; this sample will also be sufficient to estimate mean length-at-age and weight in our secondary objectives for which we have no precision criteria. In 2014 the respective averages of length and weight were 89.4 mm and 7.4 g. If we tag 9,585 smolt as anticipated and systematically sample every 25th coho salmon smolt ≥75 mm FL, the resulting sample of 383 is larger than required to meet objective 6 criteria.

We will systematically sample every 100th Chinook salmon parr ≥50 mm FL during the fall 2014, and every 20th Chinook salmon smolt during spring 2015 for length and weight (BY 2012 mean = 68.9 mm and 3.9 g).

## HARVEST OF CHINOOK SALMON FROM THE 2013 BROOD YEAR

Recovery of coded-wire tagged Chinook salmon in the various fisheries in 2016–2020 (to sample age-1.1 to age-1.5 fish) will be used to estimate the total marine harvest of Chinook salmon from the Chilkat River from BY 2013. To meet the criterion in Objective 2 (90% relative precision = ±35%), approximately 10,500 Chinook salmon smolt from BY 2013 emigrating in 2015 need to be marked with CWTs according to procedures in Bernard et al. 1998 (see example in the next paragraph and Appendix A3). Because we expect 13,556 Chinook salmon smolt to be marked, the objective criteria should be met. The sample size calculation is based on historical inspection of 50% of commercial harvests, 46% of the recreational harvests, and 32% of the subsistence harvest, for an overall marine fishery sampling rate of 46%, an estimated 175,015 smolt leaving the Chilkat River in 2015, an ocean survival rate of 3.0% for smolt, and an overall marine exploitation rate of 19.2% for adults (Appendix A2).

A simulated data set to anticipate harvest from the 2013 Chilkat Chinook brood, based on the above assumptions and past recoveries of Chilkat River CWTs from BYs 1999–2006, suggests that Objective 2 will likely be met (Appendix A3). We anticipate that under average fishing regimes 36.6% of the total harvest of Chilkat Chinook salmon will be taken in sport fisheries, 17.3% in the commercial troll fishery, 32.3% in the commercial gillnet and purse seine fisheries, and 13.8% in the subsistence gillnet fishery (Appendix A2). Using a 45% overall sampling rate in marine fisheries, we expect that 67 Coded-wire tagged fish will be recovered, of which 27 are anticipated to be random recoveries of coded-wire tagged Chilkat River Chinook salmon. Probabilities for recovery of a Chilkat River CWT at varying ages from different fisheries were based on historical recoveries of Chilkat River CWTs. In efforts to represent all principal fisheries, including gear, area, and time, for Chilkat CWT recoveries, there are numerous instances when the calculated value for $m_i$ is less than one. There are, therefore, several low probabilities in this exercise for recovery of a Chilkat River Chinook salmon CWT. Methodology in Bernard et al. (1998) was used to estimate the chance of missing harvest in fisheries. Reported harvests in each stratum are not large (generally less than 100 fish), and our expectation is for the recovery of only 1 CWT in some commercial fishery strata. The average anticipated probability of recovering a CWT from each time-area-fishery stratum is 41%, and the probability of getting CWTs in all strata (the product of the individual stratum probabilities) is less than 1%. Despite this low probability, harvests in most individual strata are small, and the loss of some harvest estimates will not be critical. Given the significant current fishery sampling effort and 9.1% average marked fraction (Table 4), there is little that can be done to improve the situation at this time.

Protocols for the collection of data from adult Chinook salmon at the ADF&G fish wheels and drift gillnets and in the marine commercial fishery can be found in operational plans developed by SF and CF for these projects. The CF operational plans can be obtained from the CF Area Management Biologist in Haines.

### HARVEST OF COHO SALMON IN 2016

Almost all coho salmon smolt tagged in 2015 that avoid mortality will emigrate to sea, mature, and return to the Chilkat River watershed to spawn in 2016. Some returning adults will be harvested in marine sport and commercial fisheries, which are sampled for missing adipose fins and head recovery by the CF port sampling program. Recoveries of CWTs from Chilkat River coho salmon tagged in 2015 will be used to estimate that cohort's contribution to the sampled fisheries in 2016 (Objective 4; Bernard and Clark 1996).

Historical data from port sampling efforts from 2000 through 2013, along with smolt tagging data for these cohorts, was used to calculate average recovery probabilities ($\pi_i$) of tagged adults bound for the Chilkat River by sport and commercial fishery recovery strata (Bernard et al. 1998). A simulation based on these recovery probabilities was then used to anticipate precision of the contribution estimate to the marine commercial and recreational fisheries for 2016. The simulation (Appendix A4) assumes an average smolt abundance of 1,286,773, the number of valid tagged coho salmon smolt of 9,585, an average (2000–2013) harvest of 1.4 million fish of mixed stock, typical port sampling efforts by strata, and an average adult escapement sample of 2,351 1-ocean adults in 2016. These assumptions result in an anticipated fraction of valid tags ($\theta_{\text{marine}}$) of 0.74% and an estimated recovery of 99 Coded-wire tagged coho salmon bound for the Chilkat River in 2016 (Appendix A4). The estimate of relative precision for the 2016 harvest estimate is ±17.5% for a 90% confidence interval. This is within the desired objective criteria of ±25%.

Methodology in Bernard et al. (1998) was used to estimate the chance of missing harvest in fisheries. Anticipated recoveries of fish bound for the Chilkat River in most sport and seine fisheries strata are small (less than 1 tag), which leads to relatively small probabilities of recovering tags in these strata (Appendix A4). However, the total contribution from *all* sport and seine strata is 3% of the total (2% from sport, 1% from seine strata). Thus, missing harvest from a significant fraction of these strata does not lead to a significant bias in the total contribution estimate. Excluding strata where <1 tag recovery is expected suggests the probability of recovering CWTs in *all* other strata (the product of all individual stratum probabilities) is about 33%. Furthermore, the probability of recovering CWTs in all of the major strata (expected tag recovery >2, including troll and District 115 gillnet) is 96%.

# DATA COLLECTION

### SMOLT ABUNDANCE

All captured coho salmon smolt ≥75 mm FL (spring 2015) and all Chinook salmon ≥50 mm FL (fall 2014 and spring 2015) without CWTs will be tranquilized with a buffered MS 222 solution, tagged with a CWT following procedures described in Koerner (1977), marked with an adipose fin clip, and released. All tagged fish will be held overnight to test for mortality and 100 of each species will be tested for retention of their tags. Any smolts captured that have missing adipose fins prior to tagging will be passed through a magnetic tag detector and the presence or absence of a CWT will be recorded. In addition, the tag location of all Chinook salmon will be verified with a wand detector.

A short section of each spool of coded wire will be taped to the SPORT FISH DIVISION SALMON SMOLT CWT DAILY LOG form (Appendix B1) the first day of tagging with a new tag code. In addition, a short section of the beginning and ending wire for each location (i.e., Tahini River, Kelsall River, and Chilkat River) will be taped to the CWT Daily Log. A new form will be started for each tagging day. All tag and recapture data will be recorded daily on the CWT Daily Log form. The field crews will record tagging site GPS coordinates in field notebooks following the instructions found in Appendix C1. The crews will record detailed trapping information in field notebooks following the protocols in Appendix B2. Catch, tagging, release, and recapture data for each day's operation will be summarized on the MINNOW TRAP SUMMARY FORM, an example of which is found in Appendix B3. Daily procedures follow.

### Fall 2014 Chinook Parr Tagging

1. Record location, date, and species on the SALMON SMOLT CWT DAILY LOG.
2. Record water and air temperature (Min-Max) to nearest 1°C, and water depth to the nearest cm on the MINNOW TRAP SUMMARY FORM. Data should be collected at 0900 each day.
3. At 0830–0900 hrs mix the fish in the holding net pen for each tag code and check 100 that are representative for tag retention and record on the SALMON SMOLT CWT DAILY LOG. If tag retention is 98/100 or greater, empty the net pen and count and record mortalities, transport to release site, and release all fish. If tag retention is 97/100 or less, reprocess the entire batch and retag all fish that test negative.
4. Check minnow traps and transport to tagging site. Sort Chinook salmon ≥50 mm FL from other species (coho salmon are not tagged). Inspect each live fish and count the number with adipose clips and record the number under "Recaptures" on the SALMON SMOLT CWT DAILY LOG. Check all recaptures for tag retention, record results, and release all recaptures with CWTs. Retag all recaptures without CWTs.
5. Give all live untagged fish a CWT and pass each through the tag detector. If rejected by the detector, retag and tally all retags on a hand counter. Write the beginning and ending machine numbers on the SALMON SMOLT CWT DAILY LOG and record retags, erroneous tags (misses, tagged fingers, etc), and practice tags. Show your calculations for the number of tags used.
6. Systematically select every 100th Chinook salmon from combined catches and measure for FL to nearest mm and record all data, including gear type and location on the CHILKAT RIVER FALL CHINOOK SAMPLING FORM (Appendix B4).

### Spring 2015 Chinook and Coho Smolt Tagging

1. Record location, date, and species on the SALMON SMOLT CWT DAILY LOG.
2. Record water and air temperature (Min-Max) to nearest 1°C, and water depth to the nearest cm on the MINNOW TRAP SUMMARY FORM. Data should be collected at 0900 each day.
3. At 0830–0900 hrs mix the fish in the holding net pen for each tag code and check a representative sample of 100 coho smolt for tag retention and record on the SALMON SMOLT CWT DAILY LOG. If tag retention is 98/100 or greater, empty the net pen and count and record mortalities, transport to release site, and release all fish. If tag retention is 97/100 or less, reprocess the entire batch and retag all fish that test negative. The same procedures apply to

Chinook salmon smolt. The snout of each fish will be will be scanned by swiping the marked side of the CWT detector wand (Vander Haegen et al. 2002) in contact with the snout at a rate of 2–3 m per second.

4. Check minnow traps and transport catch to tagging site. Sort coho salmon ≥75 mm FL and Chinook salmon ≥50 mm FL from smaller fish and other species. Inspect each live fish and count the number with adipose clips and record the number under "Recaptures" on the SALMON SMOLT CWT DAILY LOG. Check all recaptures for tag retention and tag location (for Chinook salmon smolt), record results, and release all recaptures with CWTs. Retag recaptures without CWTs.
5. Give all live untagged fish a CWT and pass each through the tag detector. If rejected by the detector, retag and tally all retags on a hand counter. Write the beginning and ending machine numbers on the SALMON SMOLT CWT DAILY LOG and record retags, erroneous tags (misses, tagged fingers, etc), and practice tags. Show your calculations for the number of tags used.
6. Systematically select every 25$^{th}$ coho salmon and measure for FL to nearest mm, weigh to nearest 0.1 g, sample for scales, and record all data, including gear type and location on the CHILKAT RIVER COHO SALMON AWL FORM (Appendix B5).
7. Systematically select every 20$^{th}$ Chinook salmon from combined catches and measure for FL to nearest mm and record all data, including gear type and location (Appendix B4).

At the end of the fall 2014 and spring 2015 tagging seasons, daily tagging information will be entered into CWT Online Release Entry software program (http://www.taglab.org), which will estimate the number of smolts that had retained CWTs and will submit the tag release information to the Tag Lab (Appendix B6). A 5 cm length of each code wire used will be attached to a TAG CODE VERIFICATION FORM and mailed to the Tag Lab for code verification.

For coho salmon smolt sampled for length, weight and scales, remove 12 to 15 scales from the preferred area (Scarnecchia 1979) on the left side of the coho salmon smolt. Sandwich scales from up to 4 fish between two 25 x 75 mm microscope slides, and tape the slides together with transparent tape. Write the length of each fish on the frosted portion of the bottom slide in accordance with the position of the scales on the slide (Figure 6). Instructions to improve our ability to read scales (as determined by Sue Millard, ADF&G-SF, retired, through experience) are:

1. Don't tape over any scales,
2. Make sure scales are placed and remain in the designated area for each fish,
3. Always number each slide at the top,
4. Always put your initials under the slide number,
5. Spread scales out so they don't contact one another and align them as shown in Figure 6,
6. Remember to clean the scalpel of scales between samples.

Once Chilkat River Chinook salmon from BY 2013 have been captured, implanted with CWTs, marked with adipose fin clips, and released during the two tagging projects (fall 2014 and spring 2015), monitoring and recovery of these tags begins and continues over a 5 year period. Between 2016 and 2020, ADF&G will sample landings from commercial, sport and subsistence fisheries throughout Southeast Alaska and Yakutat for adipose fin clips and CWTs. The sample goal will be to inspect at least 20% of the total catch of Chinook salmon for missing adipose fins.

Heads from fish missing their adipose fin will be sent to ADF&G's Juneau Tag Lab where CWTs will be removed and decoded. The annual ADF&G port sampling manual (*Coded wire tag sampling program detailed sampling instructions, commercial fisheries sampling*; located at Alaska Department of Fish and Game, Division of Commercial Fisheries, 802 3rd Street, Douglas, Alaska) provides a detailed explanation of commercial catch sampling procedures and logistics.

The number of BY 2013 Chilkat River Chinook salmon CWTs recovered 2016–2020 in all marine fisheries (commercial, sport, and subsistence) will be compiled by release group, i.e. fall 2014 or spring 2015, which is determined by the specific tag code from successfully read CWTs.

In addition to marine fisheries sampling, heads will also be collected from Chinook salmon with missing adipose fins during Chilkat River escapement sampling from 2016 through 2020. Escapement sampling is conducted annually in the Chilkat River drainage to estimate inriver abundance. Heads will not be collected from large (≥660 mm FL) fish in pre-spawning condition. The brood year of adipose-finclipped fish whose heads are not taken will be determined from scale age samples. All adipose finclipped fish will be examined with a handheld wand CWT detector (Vander Haegen et al. 2002) to determine presence/absence of a CWT. Heads from fish with missing adipose fins that do not indicate presence of a CWT will be collected to detect for tag loss.

## DATA REDUCTION

It is the responsibility of the field crew leader to ensure accurate records are maintained for all data collected on a daily basis (e.g., sampling rates for age and length, correct secondary marks are applied, etc). The field crew leader will also ensure data collections (such as samplers initials, environmental data, fish length and condition, tag codes applied, etc.) are complete and methods (such as FL measurements, scale collection procedures, head mold sizes, etc.) are correctly implemented.

Data will be inspected daily for errors such as incorrect dates, transposed nonsensical lengths (210 mm when the fish was actually 120 mm), transposed or nonsensical tag numbers, incorrect tagging totals, CWT tagging lengths less than prescribed guidelines, etc. Data forms will be kept up to date at all times. Scale slides will be checked to insure that scales are clean and mounted correctly; the slides are correctly labeled, and samples are matched up with the corresponding data form. Data will be sent to the project biologist weekly, where they will be re-inspected for accuracy and compliance with sampling procedures. The project biologist will keep field data updated in Microsoft Excel™ while it is collected, in season, and produce weekly reports to other management biologists in Southeast Alaska. Ages from scale samples will be estimated in the scale aging lab in Douglas. Scale ages will be entered into the spreadsheet files. When all input is complete, data lists will be obtained and checked against the original field data.

When the final reports are complete, electronic copies of the data, along with a data map, will be sent to Research and Technical Services (RTS) for archiving. The data map will include a description of the electronic files contained in the data archive, and where copies of any associated data are to be archived, if not in RTS. After the daily CWT tagging, retention, and overnight mortality data have been entered using the CWT Online Release Entry program, the Tag Lab will maintain a permanent database of parr and smolt releases and will share this data with the Pacific States Marine Fisheries Commission.

# DATA ANALYSIS

## SMOLT AND PARR ABUNDANCE

### Chinook Salmon

A statistical model will be fit to the BY 2013 data to obtain estimates of the number of BY 2013 parr rearing in the Chilkat River in fall 2014 ($N_{PARR}$), the overwinter survival to spring 2015 ($\phi_1$), and the number of smolt outmigrating in 2015 ($N_{SMOLT}$).

We will use a form of the Petersen estimator (Seber 1982) to obtain estimates of the number of BY 2013 parr rearing in the Chilkat River in fall 2014 ($N_{PARR}$) and the number of smolt emigrating in 2015 ($N_{SMOLT}$):

$$\hat{N}_{PARR} = (M_{PARR} \text{ x } C) / \hat{R}_{PARR} \tag{1}$$

and

$$\hat{N}_{SMOLT} = (M_{SMOLT} \text{ x } C) / \hat{R}_{SMOLT} \tag{2}$$

where:

$M_{PARR}$ = number of CWTs applied to Chinook salmon parr marked during fall 2014,

$M_{SMOLT}$ = number of CWTs applied to Chinook salmon smolt marked during spring 2015,

$C = R_1 + R_2 + R_3 + R_4$ = the total number of BY 2013 Chinook salmon examined for adipose fin clips in the Chilkat River in 2016–2020,

$R_1$ = the number of fall 2014 CWTs decoded from adipose-clipped fish in the Chilkat River,

$R_2$ = the number of spring 2015 CWTs decoded from adipose-clipped fish in the Chilkat River,

$R_3$ = the number of adipose-clipped fish in the Chilkat River whose CWTs were not decoded because the head was not taken, the head was lost, or the tag was lost, and

$R_4$ = the number of fish without adipose fin clips in the Chilkat River.

In order to estimate $\hat{R}_{PARR}$ and $\hat{R}_{SMOLT,}$ we needed to estimate the proportion $\rho$ of all adipose-clipped fish in the BY 2013 population with decoded CWTs using:

$$\hat{\rho} = R_{VTOT} / (R_1 + R_2 + R_3) \tag{3}$$

where

$$R_{VTOT} = R_1 + R_2. \tag{4}$$

We will then estimate the number of fall 2014-marked adipose-clipped fish in $C$ using:

$$\hat{R}_{FRY} = R_{VTOT} * \left[ \frac{(R_1 + m_{FALL})}{(R_{VTOT} + m)} \right] \Big/ \hat{\rho} \tag{5}$$

where:

$m$ = number of BY 2013 Chilkat Chinook CWTs recovered in marine fisheries, and

$m_{FALL}$ = the CWTs from $m$ that were fall 2014 CWTs.

The number of spring 2015-marked adipose-clipped fish in $C$ will be estimated using:

$$\hat{R}_{SMOLT} = R_{VTOT} * \left\{1 - \left[\frac{(R_1 + m_{FALL})}{(R_{VTOT} + m)}\right]\right\} \Big/ \hat{\rho} \,. \qquad (6)$$

Equations (5) and (6) make use of marine data in estimating the number of 2014- and 2015-marked adipose- clipped fish. It should be noted if the ratio of marine recoveries of CWTs is much different than that of inriver ratio of CWTs, e.g. due to small sample sizes, ambiguousresults may ensue. In an extreme case where marine proportions were much different and with more weight ($m >> R_{VTOT}$), then you could end up estimating that there were less adipose clips apportioned to the fall clipping than were verified from fall adipose clips. Despite this, the marine recoveries in recent years have been similar to those inriver, and so these equations work perfunctorily.

The survival probability $\phi_1$ of BY 2013 Chinook salmon from fall 2014 to spring 2015 will be estimated as:

$$\hat{\phi}_1 = \hat{N}_{SMOLT} \Big/ \hat{N}_{FRY} \,. \qquad (7)$$

The proportion of the fall 2014 parr population marked with CWTs will be estimated using:

$$\hat{q}_{FALL} = \hat{R}_{PARR} / C \qquad (8)$$

and the estimated proportion of the spring 2015 smolt population marked with CWTs will be estimated as:

$$\hat{q}_{SPRING} = \hat{R}_{SPRING} / C. \qquad (9)$$

To estimate the error surrounding the parameters $N_{PARR}$, $\phi_1$, and $N_{SMOLT}$, a statistical model will be fit to the BY 2013 data. The number of valid CWTs from fall and spring marking events recovered from Chinook salmon sampled in the Chilkat River in 2016-2020 will be modeled as having a multinomial distribution with parameters $\pi_1$, $\pi_2$, $\pi_3$, $\pi_4$, and C, where:

$\pi_1 = q_{FALL}\ \rho$,

$\pi_2 = q_{SPRING}\ \rho$,

$\pi_3 = (q_{FALL} + q_{SPRING})\ (1\text{-}\rho)$,

$\pi_4 = 1 - \pi_2 - \pi_3$, and

$C$ = number of Chinook salmon captured in the Chilkat River and inspected for adipose clips in 2016–2020,

$q_{FALL} = M_{PARR} / N_{PARR}$

$q_{SPRING} = M_{SMOLT} / N_{SMOLT}$

$\rho$ = the proportion of adipose-clipped fish for which the head was collected and a CWT was successfully decoded,

$M_{PARR}$ = number of CWTs applied to Chinook salmon parr marked during fall 2014,

$M_{SMOLT}$ = number of CWTs applied to Chinook salmon smolt marked during spring 2015,

$N_{PARR}$ = abundance of Chinook salmon parr during the fall 2014 marking event, and

$N_{SMOLT}$ = abundance of Chinook salmon smolt during spring 2015 marking event, equal to the product of $N_{PARR}$ and

$\phi_1$ = the survival probability from fall 2014 to spring 2015.

The relative proportion of fall and spring CWTs recovered in mixed stock marine fisheries also will contain information about the survival probability $\phi_1$. Therefore the number of valid CWTs from the fall 2014 marking event recovered from Chinook salmon sampled elsewhere in 2016-2020 will be modeled as having a binomial distribution with parameters:

$\pi_{FALL} = q_{FALL} / (q_{FALL} + q_{SPRING})$, and

m = number of Chilkat fall and spring CWTs recovered in fisheries outside of the Chilkat River in 2016–2020.

Bayesian statistical methods will be used to estimate the parameters of the model. Bayesian methods use probability distributions to express uncertainty about model parameters. Inputs to the model include the "prior" probability distribution, which expresses knowledge about the parameters from previous experiments, outside the frame of the experiment itself. The output of a Bayesian analysis is the "posterior" distribution, which describes the new, updated knowledge about the parameters after consideration of the experimental data. Percentiles of the posterior distribution can be used to construct one-sided probability statements or two-sided intervals about the parameters. Point estimates are de-emphasized in Bayesian statistics, however the mean, median, or mode of the posterior can be used to describe the central tendency of a parameter. The standard deviation of the posterior distribution can be used as an analogue of the standard error of a point estimate in classical statistics.

Bayesian analyses require that prior probability distributions be specified for all unknowns in the model. A normal prior distribution with very large variance will be specified for $N_{PARR}$, essentially equivalent to a uniform distribution. A beta (0.1, 0.1) prior will be used for $\phi_1$ and $\rho$. All priors will be non-informative, chosen to have a negligible effect on the posterior.

Markov-Chain Monte Carlo simulation, implemented with the Bayesian software WinBUGS (Gilks et al. 1994), will be used to draw samples from the joint posterior probability distribution of all unknowns in the model. Three Markov chains will be initiated, a 4,000-sample burn-in period discarded, and 100,000+ updates generated to estimate the marginal posterior means, standard deviations, and percentiles. The diagnostic tools of WinBUGS will be used to assess mixing and convergence. Interval estimates will be obtained from percentiles of the posterior distribution. WinBUGS model code, data, initial values, and results from the 2005 brood year Chilkat River Chinook salmon analysis are in Appendix A5.

### Coho Salmon

The abundance $\hat{N}_s$ of coho salmon smolt (by emigration year) will be estimated using Chapman's modification of the Petersen Method (Seber 1982:60):

$$\hat{N}_s = \frac{(n_c+1)(n_e+1)}{(m_e+1)} - 1 \tag{9}$$

$$var[\hat{N}_s] = \frac{(n_c+1)(n_e+1)(n_c - m_e)(n_e - m_e)}{(m_e+1)^2(m_e+2)} \tag{10}$$

where $n_c$ is the number of valid CWTs (on fish that survive the tagging event) placed in smolt during the spring, $n_e$ is the number of age 1-ocean salmon examined in the escapement that are successfully aged and found to have been smolt that emigrated from the Chilkat River during the previous spring, and $m_e$ is the subset of $n_e$ with successfully decoded CWTs placed at that time. The marked fractions of jacks and age 1-ocean fish are not statistically different, so in the interest of parsimony, only age 1-ocean fish are used for $n_e$. Because $n_e$ represents 1-ocean coho salmon in the escapement, and this is estimated from a proportion of aged fish, there is a small amount of additional process error involved with the term $n_e$. However, because the proportion of 1-ocean fish in the population has averaged 0.97, the increase in error is small, and the increase in estimated variance is also small.

Fish sometimes lose their CWTs, CWTs can be lost from recovered heads, and CWTs can be unreadable. If any of these conditions occur, the estimators (equations 10 and 11) must be modified to compensate for the lost marks/CWTs (i.e., loss of $m_e$). This will be accomplished by adding a term $\lambda = a/t'$ (an overall rate for recovering and decoding CWTs, where a = # adipose-finclipped fish sampled and $t'$ = # CWTs decoded) to the denominator of the Lincoln-Petersen / maximum-likelihood estimator, i.e., $\hat{N}_s^* = n_c\, n_e / m_e\, \lambda$. Variance of $\hat{N}_s^*$ will be estimated using a Monte-Carlo simulation if a suitable closed form estimator is not identified. Although the Lincoln-Petersen estimator is not unbiased, the bias should be negligible in this experiment because the numbers of fish marked, inspected, and recaptured are not small (Seber 1982).

The conditions for accurate use of the M-R method for both species/experiments are:

1. One of the following three items, a through c must hold true:
    a. all smolts/parr have an equal probability of being marked; *or*
    b. adults escaping to the Chilkat River have an equal chance of being inspected for marks; *or*
    c. marked fish mixed completely with unmarked fish in the population between sampling events.
2. There is no recruitment to the population between sampling events.
3. There is no trap or tagging induced behavior.
4. Fish do not lose their marks and all marks are recognizable.

Minnow traps will be operated continuously during smolt emigrations, and returning adults will be sampled almost continuously either in fish wheel catches or spawning grounds sampling. A possible late start in tagging projects, periodic sessions of high water, or varying outmigration timing in the spring could possibly cause temporal changes in probabilities of capture. However, these vagaries are troublesome only if migratory timing of smolt from different stocks within the Chilkat River does mimic that of returning adults and these vagaries are coincident in the migratory pattern for both adults and smolt. If migratory patterns of smolt are different than that of adults, marked and unmarked smolt are completely mixed in the population prior to their return as adults. We will test for temporal changes in the fraction of adults missing adipose fins: if at least one of the conditions has been met, this fraction will not change with time. Temporal changes in these fractions will be tested against a $\chi^2$ distribution. Although fish wheels and gillnets can be size selective, their size selectivity should not be a problem because there is no relation between the size of a smolt (when marked) and the size of the returning adult (when recaptured). Because almost all surviving smolt return to their natal stream as adults to spawn, there will be no meaningful recruitment added to the population while they are at sea. Trap-induced behavior is unlikely because different sampling gears will be used to capture smolt and adults. Results from other studies (Elliott and Sterritt 1990; Vincent-Lang 1993) indicate that excising adipose fins and implanting CWTs will not increase the mortality of marked salmon.

As outlined in the Study Design section, CWT-tagging coho salmon smolt in different size groups allows for testing of M-R assumption [1], i.e., that every fish has an equal probability of being marked during event 1, that every fish has an equal probability of being captured in event 2, or that marked fish mix completely with unmarked fish. In the event that $\chi^2$ tests indicate unequal probabilities of tagging in event 1 or capture in event 2, an alternate Petersen M-R model will be used for a 2-group population.

A population divided into 2 groups labeled (1) and (2), Petersen's M-R model can be expanded into (adapted from Weller et al. 2005):

$$N_1 + N_2 = (N_1\alpha_1 + N_2\alpha_2)\frac{N_1\alpha_1 S_1 B_1 + N_2\alpha_2 S_2 B_2 + N_1(1-\alpha_1)S_1 B_1 + N_2(1-\alpha_2)S_2 B_2}{N_1\alpha_1 S_1 B_1 + N_2\alpha_2 S_2 B_2} \quad (11)$$

In the above equation, $N$ is abundance, $\alpha_i$ is the capture probability in event 1 for each group, $S_i$ the survival rate for each group, and $\beta_i$ the capture probability for each group.

If one or both capture probability parameters, $\alpha_i$ or $\beta_i$, are equal, then the above equation reduces to a more simplified version. Consider the case when $\beta_1 = \beta_2$, the abundance estimator reduces to:

$$N_1 + N_2 = (N_1\alpha_1 + N_2\alpha_2)\frac{N_1\alpha_1 S_1 + N_2\alpha_2 S_2 + N_1(1-\alpha_1)S_1 + N_2(1-\alpha_2)S_2}{N_1\alpha_1 S_1 + N_2\alpha_2 S_2} \quad (12)$$

If the relationship between $\alpha_i$ parameters is expressed as $A = \alpha_2 / \alpha_1$ and the relationship between $S_i$ parameters is expressed as $B = S_2 / S_1$, equation (13) reduces further to:

$$N_1 + N_2 = \frac{(N_1 + AN_2)(N_1 + BN_2)}{N_1 + ABN_2} \quad (13)$$

It is important to note that equation (14) is only true if $A = 1$ (i.e. $\alpha_2 = \alpha_1$) OR if $B = 1$ ($S_2 = S_1$). If both $A$ and $B$ are not equal to 1, the above relationship does not hold and an unbiased estimator of abundance cannot be produced. If it is determined that there are both unequal marking probabilities (event 1) and unequal capture or survival probabilities (event 2), Petersen's model can be adjusted to produce an unbiased estimate of smolt abundance. Consider Chapman's modification of the standard Petersen model with 2 tagging groups, labeled group 1 and group 2:

$$\hat{N} = \frac{(N1_1 + N1_2 + 1)(N2 + 1)}{(M2_1 + M2_2 + 1)} \tag{14}$$

where $N1_1$ and $N1_2$ are the number marked in groups 1 and 2, $N2$ is the number inspected for marks in the second event, and $M2_1$ and $M2_2$ are the amount of marks recovered from groups 1 and 2. Consider the case where $A > 1$ and $S > 1$, that is, group 2 had both a higher marking probability and capture probability. This would create negative bias in the estimator and $N > \hat{N}$. Adjusting Chapman's modification for this tagging bias results in a new, unbiased estimator:

$$\hat{N}^* = \frac{(\hat{A}N1_1 + N1_2 + 1)(N2 + 1)}{\hat{A}M2_1 + M2_2 + 1} - 1 \tag{15}$$

Using the scalar $\hat{A}$, i.e., the ratio of marking rates of the 2 groups, essentially forces the two groups to have the same marking probability, and therefore the expected value of equation (15) equals $N$ as a result.

Retention rates for Coded-wire tagged fish are rarely 100%; adipose-finclipped fish sometime do not contain valid CWTs as tags are shed during freshwater or marine rearing. Also occasionally heads are lost from adipose-finclipped fish before they can become decoded. Because of this, a new parameter $\hat{\pi}$ can be used to adjust for adipose-finclipped fish with no tag information ($M2_U$), which is the observed ratio of tags recovered from group 1 divided by group 2. Basically the observed recovery rate is extrapolated for fish marked in the first event (as indicated by an adipose fin clip) that contain no tag information:

$$\hat{N}^* = \frac{(\hat{A}N1_1 + N1_2 + 1)(N2 + 1)}{\hat{A}(M2_1 + (\hat{\pi})M2_U) + M2_2 + (1 - \hat{\pi})M2_U + 1} - 1 \tag{16}$$

In the event that all observed adipose-finclipped fish contain valid CWTs, the term $M2_U$ is zero and equation (16) is identical to equation (15).

Variance and relative bias in the modified estimator can be estimated through bootstrapping techniques outlined in Efron and Tibshirani (1993).

## AGE COMPOSITION

Proportions and variance or proportions by age for coho salmon smolt and adults will be estimated:

$$\hat{p}_j = \frac{n_j}{n} \tag{17}$$

$$\hat{\text{var}}[\hat{p}_j] = \frac{\hat{p}_j(1-\hat{p}_j)}{n\text{-}1} \tag{18}$$

where $\hat{p}_j$ is the estimated proportion in the population in group $j$, $n$ is the number successfully aged, and $n_j$ is the subset of $n$ that belong to group $j$. Systematic selection of samples will promote proportional sampling and reduce bias from any inseason changes in age composition.

Collecting scale samples in fall 2016 from all returning adult coho salmon with clipped adipose fins will be done to provide the scale ager with known-age reference samples. Collecting age information from adipose-finclipped coho salmon will also allow for calculation of an unbiased smolt estimator discussed above.

## ESTIMATES OF MEAN LENGTH

Standard sample summary statistics will be used to calculate estimates of mean length of Chinook salmon parr or mean length-at-age of coho salmon smolt and adults, and their variances (Thompson 2002).

## ESTIMATION OF THE CODED WIRE TAG MARKED FRACTION

The marked fractions for populations of BY 2013 Chinook salmon and for emigration year 2015 coho salmon will each be estimated separately:

$$\hat{\theta}_p = \frac{\mathrm{y}_p}{\mathrm{t}_p} \tag{19}$$

where

$\hat{\theta}_p$ = the proportion of juveniles from brood year $p$ or emigration year $p$ marked with a CWT,

$\mathrm{y}_p$ = number of fish in the sample missing their adipose fin that are determined to be from brood year $p$ or emigration year $p$, and

$\mathrm{t}_p$ = number of fish in the sample determined to be from brood year $p$ or emigration year $p$.

For BY 2013 Chinook salmon, the CWT marked fraction will be estimated form adult inriver mark-recapture project event 1 and 2 data in years 2016–2020 using methods detailed in the Chilkat River Chinook salmon escapement operational plan (Elliott et al. 2014). The potential for the Chinook salmon $\theta$ to vary significantly by recovery area (e.g., lower river, Tahini River, Kelsall River, etc.) will be investigated using a series of $\chi^2$ tests similar to those described above. If differences in the marked fractions are significant ($\alpha$ = 0.10) and large enough to lead to serious bias in estimates of smolt abundance or fisheries contributions, only samples collected in the lower river will be used to estimate $\theta$. Deterministic modeling was done to estimate the effect on $\theta$ of tagging smolt non-proportionally on the 2 main spawning areas (Table 8). The model assumes sampling on the spawning grounds would proceed as it has in the past. As the fraction marked in the Tahini River area diverges from the fraction marked in the Kelsall River area, the estimate of $\theta$ for the river, based on spawning ground samples, varies very little. This occurs because samples are distributed from the bulk of the spawning population. Also, the model suggests that the usual $\chi^2$ test will indicate that problems exist well before they are severe enough to lead to serious bias in estimates of parr abundance or fisheries contributions (bias in those estimates is approximately proportional to bias in $\theta$ for the river). For example, as tagging fractions for the upriver and downriver rearing areas diverge by 100% ($\theta_{Tahini}$ = 0.089 and $\theta_{Kelsall}$ = 0.179), the resulting estimate of $\theta_{WholeRiver}$ = 0.148 varies by only 3.8% from its true value.

For emigration year 2015 coho salmon, the CWT marked fraction will be estimated using adult sampling data collected at the lower river fish wheel sampling site in 2016.

To estimate contributions to mixed stock marine fisheries, it is necessary to account for CWT tag loss, which prevents recognition of the stock of origin. For each Coded-wire tagged population (BY 2013 Chinook salmon, emigration year 2015 coho salmon) the marked fraction $\hat{\theta}_{marine}$ used in harvest estimates will be the product of $\hat{\theta}_p$ and the proportion of heads with decoded CWTs out of the heads sent to the Tag Lab.

## Harvest

Harvest of Chilkat River coho will be estimated by calendar year, and Chinook salmon will be estimated both by calendar year and brood year through a stratified catch sampling program of commercial and recreational fisheries. Methods in Bernard and Clark (1996) will be used to expand harvest estimates from recovered CWTs. Commercial catch data for the analysis will be summarized by ADF&G statistical week and district (for gillnet and seine fisheries), or by period and quadrant for troll fisheries. Sport harvest estimates from ADF&G Statewide Harvest Survey reports (e.g., Jennings et al. 2007) will be apportioned using information from sampled marine sport fisheries to obtain estimates of total harvest by biweek and fishery. Sport fish CWT recovery data will be obtained from Tag Lab reports and summarized by biweek and fishery (e.g., biweek 16 during the Sitka Marine Creel Survey) to estimate contribution. In most cases, CWTs of interest may be recovered in only a few of the sport fish sampling strata that defined the fishery biweek. Assuming that the harvests of fish with CWTs of interest are independent of sampling strata within fishery biweeks, harvests and sampling information will be totaled over the fishery biweek to estimate contributions."

The estimates will be based on information from SF and CF sampling of:

1. number of salmon harvested by species;
2. fraction of the harvest inspected for missing adipose fins;
3. number of salmon in the sample with missing adipose fins;
4. number of fish heads that reached the Tag Lab;
5. number of these heads that contained CWTs;
6. number of these CWTs that were decodable; and
7. number of decodable tags of the appropriate code(s).

As noted above, estimating tagging fractions $\theta$ for Chinook salmon is complicated by adults returning over 5 years. Data from all sample years will be pooled to estimate $\hat{\theta}_{marine}$ for the harvest study.

# SCHEDULE AND DELIVERABLES

Adult coho salmon will be sampled in the fish wheels beginning about August 1 and extending through October 15, 2016. Field activities for Chinook salmon parr will begin inriver approximately September 16, 2014 and extend through October 31, 2014. Data editing and analysis will be initiated before the end of each season. A memorandum summarizing fall field activities, successes, and suggestions for improvement will be submitted to the project biologist by November 30. Field activities for smolt will begin inriver approximately April 3, 2015, and extend until May 15, 2015, or as river conditions permit. Data editing and analysis will be initiated before the end of each season. A memorandum summarizing smolt field activities, successes, and suggestions for improvement will be submitted to the regional Chinook salmon research coordinator by June 15, 2015.

Juvenile Chinook trapping and tagging data collected in this study will be reported in a Division of Sport Fish Fishery Data Series report and submitted by December 31, 2020. Coho salmon smolt data collected in 2015 will be reported in a Division of Sport Fish Fisheries Data Series report and submitted by December 1, 2017. This report will cover all 2015 smolt data and subsequent recoveries, harvest contributions, etc. of adult coho salmon in 2016. Chinook parr and smolt data including adult harvests will be reported by December 2020.

# RESPONSIBILITIES

Brian W. Elliott, FB II, Lead Biologist. The Lead Biologist sets up all major aspects of the project, including planning, budget, sample design, permits, equipment, personnel, and training. This position will oversee all field operations for juvenile tagging and adult abundance estimation. This position will also assist in the field during the spring CWT project, including tagging, data collection, and general field duties. This position also supervises the overall project; edits, analyzes, and reports Chinook salmon data; assists with fieldwork; arranges logistics with the field crew, area management biologist, and expeditor. Coauthors operational plan and assures that it is followed or modified appropriately.

Sarah Power, Biometrician II. The Biometrician provides input to and approves sampling design. Coauthors operational plan and provides biometric details. Reviews and assists with data analysis and final report.

Jeff Nichols, Regional Research Supervisor (acting). The Regional Research Supervisor provides input to and approves sampling design. Reviews operational plan and provides operational details. Reviews and assists with data analysis and final report.

Richard Chapell, FB III, Area Management Biologist (AMB). The AMB performs index counts for the adult coho escapement estimation project. This position will periodically participate in field operations during the spring CWT project. The AMB will also derive harvest estimates from the Haines marine boat fishery. This position will direct field activities from the Haines ADF&G Office in the absence of Lead Biologist.

Dana Van Burgh, Reed Barber, and Aaron Thomas, FWT III. These positions act as crew leaders for CWT operations and make sure the operational plan is followed. Crew leaders will be in charge of running minnow trap lines, and adjusting traps to maximize catches, and are responsible for recording all daily records on daily forms. These positions are responsible for assisting in all aspects of field operations, including safe operation of riverboats and all other equipment, tagging, data collection, and general field camp duties including keeping camp and field equipment neat and orderly. They will be the lead smolt taggers and are responsible, along with Elliott, for making sure that species identification is done correctly and that tag retention is at or near 100%. Will take the lead roles in any construction activities and will be in charge of equipment maintenance (outboards, CWT machines, detectors, power tools, generators, etc). Will do inventory at end of year in cooperation with Elliott.

Mark Brouwer, Lyndsey Hura, and Liam Cassidy, FWT II. These positions are responsible for assisting in all aspects of field operations, including safe operation of riverboats and all other equipment, tagging, data collection and general field camp duties including keeping camp and field equipment neat and orderly. These positions are typically clippers in tagging shed, but may be trained as taggers, and will assist crew leaders with data collection and entry as needed.

Dave Folletti, FWT III (Commercial Fish Division). As leader of the Chilkat River fish wheels project, this position will capture and sample adult Chinook and coho salmon for age, sex, length, and adipose fin clip status. This position will also collect heads from ad-clipped fish that meet the CWT recovery criteria. This position will also submit sample data in a timely manner to the Lead Biologist.

# TABLES AND FIGURES

(Tables 1 – 8; Figures 1 – 6)

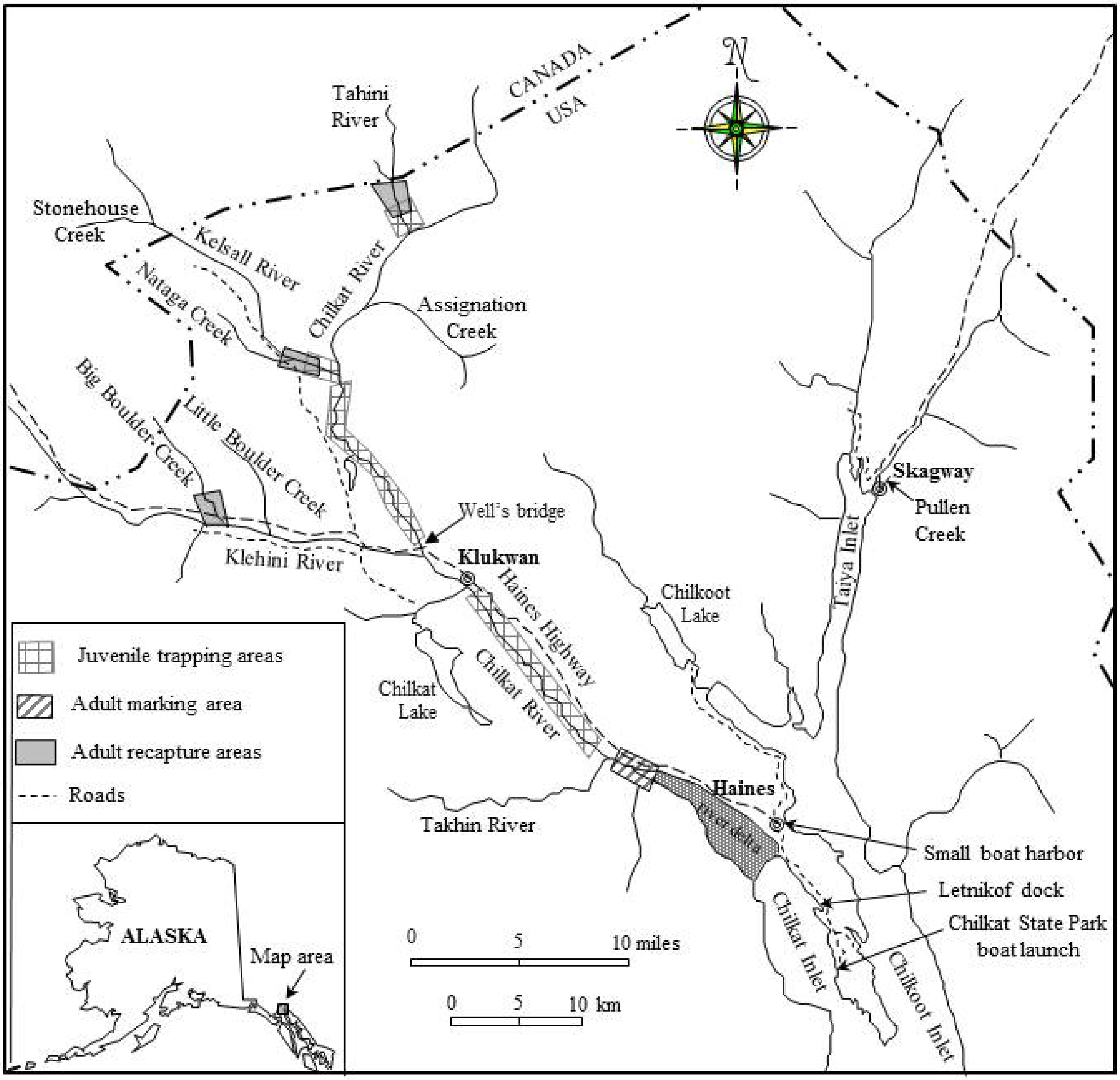


Figure 1.–Chinook salmon sampling sites in the Chilkat River drainage in Southeast Alaska.

Table 1.–Estimated angler effort, and large Chinook salmon catch and harvest in the Haines marine boat sport fishery for comparable sample periods, 1984–2013.

| | | Effort | | | | Large (28") Chinook salmon | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | Survey dates | Angler-hr | SE | Salmon-hr | SE | Catch | SE | Harvest | SE | CPUE[a] |
| 1984[b] | 5/06-6/30 | 10,253 | [c] | 9,855 | [c] | 1,072 | [c] | 1,072 | [c] | 0.109 |
| 1985[d] | 4/15-7/15 | 21,598 | [c] | 20,582 | [c] | 1,705 | [c] | 1,696 | [c] | 0.083 |
| 1986[e] | 4/14-7/13 | 33,857 | [c] | 32,533 | [c] | 1,659 | [c] | 1,638 | [c] | 0.051 |
| 1987[f] | 4/20-7/12 | 26,621 | 2,557 | 22,848 | 2,191 | 1,094 | 189 | 1,094 | 189 | 0.048 |
| 1988[g] | 4/11-7/10 | 36,222 | 3,553 | 32,723 | 3,476 | 505 | 103 | 481 | 101 | 0.015 |
| 1989[h] | 4/24-6/25 | 10,526 | 999 | 9,363 | 922 | 237 | 42 | 235 | 42 | 0.025 |
| 1990[i] | 4/23-6/21 | [i] | [i] | 11,972 | 1,169 | 248 | 60 | 241 | 57 | 0.021 |
| 1993[j] | 4/26-7/18 | 11,919 | 1,559 | 9,069 | 1,479 | 349 | 63 | 314 | 55 | 0.038 |
| 1994[k] | 5/09-7/03 | 9,726 | 723 | 7,682 | 597 | 269 | 41 | 220 | 32 | 0.035 |
| 1995[l] | 5/08-7/02 | 9,457 | 501 | 8,606 | 483 | 255 | 42 | 228 | 41 | 0.030 |
| 1996[m] | 5/06-6/30 | 10,082 | 880 | 9,596 | 866 | 367 | 43 | 354 | 41 | 0.038 |
| 1997[n] | 5/12-6/29 | 9,432 | 861 | 8,758 | 697 | 381 | 46 | 381 | 46 | 0.044 |
| 1998[o] | 5/11-6/28 | 8,200 | 811 | 7,546 | 747 | 222 | 60 | 215 | 56 | 0.029 |
| 1999[p] | 5/10-6/27 | 6,206 | 736 | 6,097 | 734 | 184 | 24 | 184 | 24 | 0.030 |
| 2000[q] | 5/08-6/25 | 4,428 | 607 | 4,043 | 532 | 103 | 34 | 49 | 12 | 0.025 |
| 2001[r] | 5/07-6/24 | 5,299 | 815 | 5,107 | 804 | 199 | 26 | 185 | 26 | 0.039 |
| 2002[s] | 5/06-6/30 | 7,770 | 636 | 7,566 | 634 | 343 | 40 | 337 | 40 | 0.045 |
| 2003[t] | 5/05-6/29 | 10,651 | 596 | 10,055 | 578 | 405 | 40 | 404 | 40 | 0.040 |
| 2004[u] | 5/10-6/27 | 12,761 | 763 | 12,518 | 744 | 413 | 46 | 403 | 44 | 0.033 |
| 2005[v] | 5/09-6/26 | 12,641 | 1,239 | 12,287 | 1,216 | 260 | 31 | 252 | 31 | 0.021 |
| 2006[w] | 5/08-6/25 | 8,172 | 610 | 7,869 | 558 | 176 | 15 | 165 | 13 | 0.022 |
| 2007[x] | 5/07-6/24 | 7,411 | 725 | 7,223 | 690 | 285 | 43 | 285 | 43 | 0.039 |
| 2008[y] | 5/05-6/22 | 1,211 | 177 | 1,132 | 167 | 27 | 11 | 27 | 11 | 0.024 |
| 2009[z] | 5/04-6/21 | 7,405 | 534 | 7,267 | 520 | 145 | 12 | 143 | 12 | 0.020 |
| 2010[aa] | 5/10-6/27 | 7,823 | 534 | 7,737 | 520 | 219 | 25 | 216 | 25 | 0.028 |
| 2011[ab] | 5/09-6/26 | 8,734 | 478 | 8,592 | 471 | 217 | 16 | 217 | 16 | 0.025 |
| 2012[ac] | 5/07-6/24 | 7,423 | 498 | 7,403 | 496 | 229 | 33 | 217 | 33 | 0.031 |
| 2013[ad] | 5/06-6/23 | 7,097 | 599 | 7,041 | 596 | 129 | 28 | 123 | 28 | 0.018 |
| 1984–1988 average | | 25,710 | | 23,708 | | 1,207 | | 1,196 | | 0.061 |
| 1989-1990, 1993-2007, 2009-2013 average | | 8,722 | | 8,163 | | 257 | | 244 | | 0.031 |

-continued-

Table 1.–Page 2 of 2.

| | | | |
|---|---|---|---|
| a | Catch of large Chinook salmon per salmon hour of effort. | p | From Ericksen (2000). |
| b | From Neimark (1985). | q | From Ericksen (2001). |
| c | Estimates of variance were not provided until 1987. | r | From Ericksen (2002). |
| d | From Mecum and Suchanek (1986). | s | From Ericksen (2003). |
| e | From Mecum and Suchanek (1987). | t | From Ericksen (2004). |
| f | From Bingham et al. (1988). | u | From Ericksen (2005). |
| g | From Suchanek and Bingham (1989). | v | From Ericksen and Chapell (2006). |
| h | From Suchanek and Bingham (1990). | w | From Chapell (2009). |
| i | From Suchanek and Bingham (1991); no estimate of total angler effort and harvest was provided | x | From Chapell (2010). |
| j | From Ericksen (1994). | y | From Chapell (2012). |
| k | From Ericksen (1995). | z | From Chapell (2013a) |
| l | From Ericksen (1996). | aa | From Chapell (2013b) |
| m | From Ericksen (1997). | ab | From Chapell (*In prep* a) |
| n | From Ericksen (1998). | ac | From Chapell (*In prep* b) |
| o | From Ericksen (1999). | ad | From Elliott and Chapell (*in prep*) |

Table 2.–Estimated sport harvest of wild mature Chinook salmon in the Haines marine boat fishery and inriver run of large Chinook salmon in the Chilkat River, 1991–2013.

| | Sport harvest | | Chilkat River abundance | |
|---|---|---|---|---|
| Year | Wild mature Chinook | Standard error | Large (≥age-1.3) Chinook | Standard error |
| 1991 | Sport Fishery Closed | | 5,897[a] | 1,005 |
| 1992 | Sport Fishery Closed | | 5,284[b] | 949 |
| 1993 | 252[c] | 46 | 4,472[d] | 851 |
| 1994[e] | 190 | 29 | 6,795 | 1,057 |
| 1995[f] | 193 | 35 | 3,790 | 805 |
| 1996[g] | 257 | 29 | 4,920 | 751 |
| 1997[h] | 311 | 41 | 8,100 | 1,193 |
| 1998[i] | 153 | 51 | 3,675 | 565 |
| 1999[j] | 82 | 11 | 2,271 | 408 |
| 2000[k] | 27 | 8 | 2,035 | 334 |
| 2001[l] | 126 | 20 | 4,517 | 722 |
| 2002[m] | 272 | 37 | 4,051 | 429 |
| 2003[n] | 285 | 27 | 5,657 | 690 |
| 2004[o] | 269 | 29 | 3,422 | 456 |
| 2005[p] | 165 | 26 | 3,366 | 555 |
| 2006[q] | 86 | 9 | 3,027 | 437 |
| 2007[r] | 177 | 33 | 1,442 | 278 |
| 2008[s,t] | 5 | 2 | 2,905 | 544 |
| 2009[u] | 80 | 10 | 4,429 | 747 |
| 2010[v] | 121 | 19 | 1,815 | 226 |
| 2011[w] | 174 | 13 | 2,688 | 318 |
| 2012[x] | 153 | 30 | 1,744 | 129 |
| 2013[y] | 74 | 26 | 1,730 | 388 |

[a] From Johnson et al. (1992).
[b] From Johnson et al. (1993).
[c] From Ericksen (1994).
[d] From Johnson (1994).
[e] From Ericksen (1995).
[f] From Ericksen (1996).
[g] From Ericksen (1997).
[h] From Ericksen (1998).
[i] From Ericksen (1999).
[j] From Ericksen (2000).
[k] From Ericksen (2001).
[l] From Ericksen (2002).
[m] From Ericksen (2003).
[n] From Ericksen (2004).
[o] From Ericksen (2005).
[p] From Ericksen and Chapell (2006).
[q] From Chapell (2009).
[r] From Chapell (2010).
[s] From Chapell (2012).
[t] Chilkat Inlet was closed to Chinook salmon retention in 2008.
[u] From Chapell (2013a)
[v] From Chapell (2013b)
[w] From Chapell (*In prep* a)
[x] From Chapell (*In prep* b)
[y] From Elliott and Chapell (*In prep*)

Table 3.–Number of live coded wire tagged Chinook salmon released into the Chilkat River by brood year (BY) and year of release, through spring 2013.

| BY | Capture/release site | Release year | Stage | Total marked | Shed tags | Valid tags |
|---|---|---|---|---|---|---|
| 1984 total | Tahini River | 1985 | Fed parr | 42,961 | 601 | 42,360 |
| 1985 total | Tahini River | 1986 | Fed parr | 46,478 | 1,457 | 44,120 |
| 1987 total | Kelsall River | 1988 | Parr | 4,553 | 0 | 4,553 |
| 1988 | Chilkat River | 1989 | Parr | 9,897 | 119 | 9,778 |
| 1988 | Chilkat River | 1990 | Smolt | 2,220 | 29 | 2,191 |
| 1988 | Kelsall River | 1989 | Parr | 20,199 | 120 | 20,079 |
| 1988 | Tahini River | 1989 | Parr | 5,293 | 0 | 5,293 |
| 1988 total | | | | 37,609 | 268 | 37,341 |
| 1989 | Chilkat River | 1990 | Parr | 2,230 | 0 | 2,230 |
| 1989 | Kelsall River | 1990 | Parr | 10,242 | 82 | 10,160 |
| 1989 | Tahini River | 1990 | Fed parr | 30,146 | 180 | 29,966 |
| 1989 | Tahini River | 1990 | Parr | 1,403 | 0 | 1,403 |
| 1989 total | | | | 44,021 | 262 | 43,759 |
| 1990 total | Tahini River | 1991 | Fed parr | 36,316 | 796 | 35,520 |
| 1991 | Big Boulder Creek | 1992 | Fed parr | 44,820 | 1,470 | 43,018 |
| 1991 | Tahini River | 1992 | Fed parr | 62,579 | 2,024 | 60,555 |
| 1991 total | | | | 107,399 | 3,494 | 103,573 |
| 1992 total | Big Boulder Creek | 1993 | Fed parr | 23,389 | 1,614 | 21,775 |
| 1993 | Big Boulder Creek | 1994 | Emergent parr | 24,324 | 243 | 24,081 |
| 1993 | Big Boulder Creek | 1994 | Fed parr | 28,062 | 1,516 | 26,546 |
| 1993 total | | | | 52,386 | 1,759 | 50,627 |
| 1994 total | Big Boulder Creek | 1995 | Emergent parr | 45,060 | 2,569 | 42,491 |
| 1995 total | Big Boulder Creek | 1996 | Emergent parr | 62,014 | 3,082 | 58,556 |
| 1997 total | Chilkat River | 1999 | Smolt | 771 | 0 | 771 |
| 1998 | Lower Chilkat | 2000 | Smolt | 446 | 0 | 446 |
| 1998 | Upper Chilkat | 2000 | Smolt | 1,550 | 0 | 1,550 |
| 1998 total | | | | 1,996 | 0 | 1,996 |
| 1999 | Chilkat River | 2000 | Parr | 6,974 | 0 | 6,974 |
| 1999 | Kelsall River | 2000 | Parr | 17,647 | 0 | 17,647 |
| 1999 | Klehini River | 2000 | Parr | 173 | 0 | 173 |
| 1999 | Tahini | 2000 | Parr | 5,310 | 0 | 5,310 |
| 1999 | Lower Chilkat | 2001 | Smolt | 4,506 | 0 | 4,506 |
| 1999 total | | | | 34,610 | 0 | 34,610 |
| 2000 | Tahini River | 2001 | Parr | 2,740 | 0 | 2,740 |
| 2000 | Kelsall River | 2001 | Parr | 10,913 | 0 | 10,913 |
| 2000 | Lower Chilkat | 2001 | Parr | 9,470 | 0 | 9,470 |
| 2000 | Lower Chilkat | 2002 | Smolt | 4,714 | 5 | 4,709 |
| 2000 total | | | | 27,837 | 5 | 27,832 |

-continued-

Table 3.–Page 2 of 3.

| BY | Capture/release site | Release year | Stage | Total marked | Shed tags | Valid tags |
|---|---|---|---|---|---|---|
| 2001 | Tahini River | 2002 | Parr | 6,519 | 0 | 6,519 |
| 2001 | Kelsall River | 2002 | Parr | 18,251 | 0 | 18,251 |
| 2001 | Lower Chilkat | 2002 | Parr | 6,620 | 0 | 6,620 |
| 2001 | Lower Chilkat | 2003 | Smolt | 2,797 | 0 | 2,797 |
| 2001 total | | | | 34,187 | 0 | 34,187 |
| 2002 | Tahini River | 2003 | Parr | 4,939 | 0 | 4,939 |
| 2002 | Kelsall River | 2003 | Parr | 17,039 | 0 | 17,039 |
| 2002 | Lower Chilkat | 2003 | Parr | 14,662 | 0 | 14,662 |
| 2002 | Lower Chilkat | 2004 | Smolt | 5,707 | 0 | 5,707 |
| 2002 total | | | | 42,347 | 0 | 42,347 |
| 2003 | Tahini River | 2004 | Parr | 5,671 | 0 | 5,671 |
| 2003 | Kelsall River | 2004 | Parr | 19,395 | 0 | 19,395 |
| 2003 | Lower Chilkat | 2004 | Parr | 12,179 | 0 | 12,179 |
| 2003 | Lower Chilkat | 2005 | Smolt | 5,825 | 16 | 5,809 |
| 2003 total | | | | 43,160 | 16 | 43,054 |
| 2004 | Tahini River | 2005 | Parr | 6,473 | 0 | 6,473 |
| 2004 | Kelsall River | 2005 | Parr | 17,867 | 0 | 17,867 |
| 2004 | Lower Chilkat | 2005 | Parr | 10,356 | 0 | 10,356 |
| 2004 | Lower Chilkat | 2006 | Smolt | 5,080 | 5 | 5,075 |
| 2004 total | | | | 39,776 | 5 | 39,771 |
| 2005 | Tahini River | 2006 | Parr | 2,832 | 0 | 2,832 |
| 2005 | Kelsall River | 2006 | Parr | 15,205 | 0 | 15,205 |
| 2005 | Chilkat River | 2006 | Parr | 281 | 0 | 281 |
| 2005 | Chilkat River | 2007 | Smolt | 2,239 | 1 | 2,238 |
| 2005 total | | | | 20,557 | 1 | 20,556 |
| 2006 | Tahini River | 2007 | Parr | 5,273 | 0 | 5,273 |
| 2006 | Kelsall River | 2007 | Parr | 12,196 | 0 | 12,196 |
| 2006 | Chilkat River | 2007 | Parr | 11,180 | 0 | 11,180 |
| 2006 | Chilkat River | 2008 | Smolt | 2,499 | 0 | 2,499 |
| 2006 total | | | | 31,148 | 0 | 31,148 |
| 2007 | Tahini River | 2008 | Parr | 3,947 | 0 | 3,947 |
| 2007 | Kelsall River | 2008 | Parr | 9,866 | 0 | 9,866 |
| 2007 | Chilkat River | 2008 | Parr | 6,361 | 0 | 6,361 |
| 2007 | Chilkat River | 2009 | Smolt | 3,911 | 0 | 3,911 |
| 2007 total | | | | 24,085 | 0 | 24,085 |
| 2008 | Tahini River | 2009 | Parr | 3,041 | 0 | 3,041 |
| 2008 | Kelsall River | 2009 | Parr | 4,784 | 0 | 4,784 |
| 2008 | Chilkat River | 2009 | Parr | 8,162 | 0 | 8,162 |
| 2008 | Chilkat River | 2010 | Smolt | 995 | 0 | 995 |
| 2008 total | | | | 16,982 | 0 | 16,982 |

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Table 3.–Page 3 of 3.

| BY | Capture/release site | Release year | Stage | Total marked | Shed tags | Valid tags |
|---|---|---|---|---|---|---|
| 2009 | Tahini River | 2010 | Parr | 7,254 | 0 | 7,254 |
| 2009 | Kelsall River | 2010 | Parr | 15,883 | 0 | 15,883 |
| 2009 | Chilkat River | 2010 | Parr | 15,703 | 25 | 15,678 |
| 2009 | Chilkat River | 2011 | Smolt | 5,514 | 0 | 5,514 |
| 2009 total | | | | 44,354 | 25 | 44,329 |
| 2010 | Tahini River | 2011 | Parr | 1,840 | 0 | 1,840 |
| 2010 | Kelsall River | 2011 | Parr | 8,534 | 0 | 8,534 |
| 2010 | Chilkat River | 2011 | Parr | 15,986 | 0 | 15,986 |
| 2010 | Chilkat River | 2012 | Smolt | 3,175 | 0 | 3,175 |
| 2010 total | | | | 29,535 | 0 | 29,535 |
| 2011 | Tahini River | 2012 | Parr | 4,973 | 0 | 4,973 |
| 2011 | Kelsall River | 2012 | Parr | 10,173 | 0 | 10,173 |
| 2011 | Chilkat River | 2012 | Parr | 11,726 | 0 | 11,726 |
| 2011 | Chilkat River | 2013 | Smolt | 5,917 | 6 | 5,911 |
| 2011 total | | | | 32,789 | 6 | 32,783 |
| 2012 | Tahini River | 2013 | Parr | 5,408 | 0 | 5,408 |
| 2012 | Kelsall River | 2013 | Parr | 6,663 | 0 | 6,663 |
| 2012 | Chilkat River | 2013 | Parr | 8,211 | 0 | 8,211 |
| 2012 | Chilkat River | 2014 | Smolt | 1,875 | 0 | 1,875 |
| 2012 total | | | | 22,157 | 0 | 22,157 |

Table 4.–Summary of Chilkat Chinook salmon stock assessment parameters from coded wire tag studies, brood years 1988–1989, 1991, and 1999–2006.

| PARAMETER ESTIMATES | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Harvest (≥age-1.1) | | | ≥Age-1.2 | | | | Smolt to ≥age-1.2 survival |
| Brood year (BY) | Fall parr | Overwinter survival | Smolt | Marked fraction, inriver | Commercial | Sport | Subsistence | Total harvest | Inriver return | Total return | Exploitation | |
| 1988[a] | ND | ND | ND | 0.037 | 910 | 719 | 9 | 1,638 | 7,111 | 8,749 | 0.187 | ND |
| 1989[a] | ND | ND | ND | 0.11 | 283 | 373 | 27 | 683 | 6,233 | 6,916 | 0.099 | ND |
| 1991[b] | ND | ND | ND | 0.048 | 681 | 374 | 58 | 1,006 | 11,900 | 12,906 | 0.078 | ND |
| 1998[c] | ND | ND | 123,680 | 0.015 | 191 | 849 | ND | 1,040 | 3,596 | 4,636 | 0.224 | 0.037 |
| 1999[d] | 386,400 | 0.364 | 139,500 | 0.113 | 589 | 972 | 252 | 1,572 | 4,764 | 6,336 | 0.248 | 0.045 |
| 2000[e] | 510,700 | 0.211 | 105,300 | 0.102 | 414 | 353 | 236 | 990 | 4,173 | 5,163 | 0.192 | 0.049 |
| 2001[f] | 596,410 | 0.249 | 148,800 | 0.076 | 407 | 304 | 192 | 821 | 4,561 | 5,382 | 0.153 | 0.036 |
| 2002[g] | 509,700 | 0.388 | 194,000 | 0.106 | 254 | 124 | 33 | 380 | 1,577 | 1,957 | 0.194 | 0.010 |
| 2003[h] | 669,200 | 0.427 | 282,700 | 0.078 | 719 | 355 | 81 | 1,125 | 5,519 | 6,644 | 0.169 | 0.024 |
| 2004[i] | 530,300 | 0.227 | 118,500 | 0.110 | 270 | 163 | 43 | 434 | 3,283 | 3,717 | 0.117 | 0.031 |
| 2005[j] | 271,700 | 0.531 | 144,200 | 0.083 | 543 | 147 | 78 | 763 | 3,165 | 3,928 | 0.194 | 0.027 |
| 2006[k] | 544,404 | 0.491 | 267,117 | 0.061 | 570 | 284 | 92 | 946 | 2,593 | 3,539 | 0.267 | 0.013 |
| 1999–2006 average | 502,352 | 0.361 | 175,015 | 0.091 | 471 | 338 | 126 | 879 | 3,704 | 4,583 | 0.192 | 0.030 |

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Table 4.–Page 2 of 2.

| STANDARD ERRORS | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Harvest (≥age-1.1) | | | ≥Age-1.2 | | | | Smolt to ≥age-1.2 survival |
| Brood year (BY) | Fall parr | Overwinter survival | Smolt | Marked fraction, inriver | Commercial | Sport | Subsistence | Total harvest | Inriver return | Total return | Exploitation | |
| 1988[a] | ND | ND | ND | 0.009 | 235 | 327 | 1 | 403 | 789 | 885 | NE | ND |
| 1989[a] | ND | ND | ND | 0.019 | 74 | 132 | 2 | 152 | 781 | 796 | NE | ND |
| 1991[b] | ND | ND | ND | 0.008 | 176 | 124 | 2 | 210 | 1,167 | 1,186 | NE | ND |
| 1998[c] | ND | ND | 30,554 | NE | 190 | 706 | ND | 731 | 488 | 879 | 12.5 | 1.2 |
| 1999[d] | 38,020 | 0.065 | 21,920 | 0.009 | 108 | 550 | 78 | 541 | 562 | 780 | 0.067 | 0.009 |
| 2000[e] | 74,290 | 0.048 | 17,170 | 0.01 | 107 | 161 | 86 | 211 | 681 | 713 | 0.042 | 0.010 |
| 2001[f] | 87,540 | 0.101 | 49,770 | 0.002 | 130 | 126 | 139 | 222 | 727 | 760 | 0.041 | 0.013 |
| 2002[g] | 81,390 | 0.106 | 47,020 | 0.015 | 77 | 52 | 3 | 93 | 234 | 252 | 0.045 | 0.002 |
| 2003[h] | 75,720 | 0.083 | 49,420 | 0.008 | 118 | 116 | 60 | 226 | 657 | 695 | 0.033 | 0.005 |
| 2004[i] | 70,280 | 0.045 | 19,180 | 0.012 | 91 | 67 | 3 | 119 | 435 | 451 | 0.031 | 0.009 |
| 2005[j] | 34,470 | 0.146 | 36,260 | 0.010 | 153 | 40 | 7 | 158 | 427 | 456 | 0.039 | 0.008 |
| 2006[k] | 166,189 | 0.188 | 77,401 | 0.009 | 176 | 84 | 9 | 196 | 347 | 398 | 0.048 | 0.004 |
| 1999–2006 average | 78,487 | 0.098 | 39,768 | 0.009 | 120 | 150 | 48 | 221 | 509 | 563 | 0.043 | 0.007 |

*Note:* ND = no data.

*Note:* NE = not estimated.

[a] Data from Ericksen (1996).

[b] Data from Ericksen (1999).

[c] Data from Ericksen and Chapell (2006).

[d] Data from Chapell (2009).

[e] Data from Chapell (2010).

[f] Data from Chapell (2012).

[g] Data from Chapell (2013a).

[h] Data from Chapell (2013b).

[i] Data from Chapell (*in prep a*).

[j] Data from Chapell (*in prep b*).

[k] Data from Elliott and Chapell (*in prep*).

Table 5.–Production parameter estimates for 1-ocean-age Chilkat River coho salmon, 2000–2013.

| Return year, t | Number CWT smolt (t-1) | Smolt theta ($\theta_s$) | Smolt estimate | SE | Marine theta ($\theta_m$) | Marine harvest | SE | Inriver harvest | SE | Age-x.1 esc | SE | Total return | SE | Marine expl | SE | Marine survival | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2000[a] | 25,915 | 0.019 | 1,237,056 | 219,715 | 0.019 | 39,546 | 3,745 | 853 | 221 | 84,843 | 16,330 | 125,242 | 16,755 | 0.32 | 0.05 | 0.10 | 0.02 |
| 2001[b] | 25,016 | 0.021 | 1,185,804 | 164,121 | 0.020 | 45,658 | 7,194 | 2,176 | 451 | 107,697 | 20,720 | 155,531 | 21,938 | 0.29 | 0.05 | 0.13 | 0.03 |
| 2002[c] | 36,114 | 0.012 | 2,970,458 | 377,695 | 0.012 | 110,105 | 10,355 | 3,888 | 742 | 204,787 | 31,071 | 318,780 | 32,759 | 0.35 | 0.04 | 0.11 | 0.02 |
| 2003[d] | 25,296 | 0.015 | 1,696,212 | 190,330 | 0.015 | 83,302 | 6,956 | 2,932 | 497 | 133,109 | 14,926 | 219,291 | 16,474 | 0.38 | 0.03 | 0.13 | 0.02 |
| 2004[e] | 24,563 | 0.012 | 1,938,322 | 401,419 | 0.010 | 128,466 | 19,882 | 3,169 | 661 | 67,053 | 12,901 | 198,688 | 23,710 | 0.65 | 0.05 | 0.10 | 0.03 |
| 2005[f] | 17,276 | 0.021 | 776,934 | 147,738 | 0.020 | 29,518 | 3,483 | 1,453 | 293 | 34,575 | 4,561 | 65,546 | 5,746 | 0.45 | 0.04 | 0.08 | 0.02 |
| 2006[g] | 26,342 | 0.014 | 1,807,837 | 217,352 | 0.013 | 70,813 | 7,632 | 2,082 | 293 | 79,050 | 15,210 | 151,945 | 17,020 | 0.47 | 0.05 | 0.08 | 0.01 |
| 2007[h] | 22,149 | 0.025 | 875,478 | 134,864 | 0.023 | 12,142 | 1,585 | 635 | 149 | 24,770 | 4,769 | 37,547 | 5,027 | 0.32 | 0.05 | 0.04 | 0.01 |
| 2008[i] | 24,104 | 0.027 | 893,032 | 95,380 | 0.025 | 52,989 | 3,518 | 991 | 261 | 56,369 | 10,846 | 110,349 | 11,405 | 0.48 | 0.05 | 0.12 | 0.02 |
| 2009[j] | 23,059 | 0.032 | 716,689 | 88,013 | 0.031 | 30,558 | 2,585 | 2,424 | 421 | 47,911 | 9,219 | 80,893 | 9,584 | 0.38 | 0.05 | 0.11 | 0.02 |
| 2010[k] | 24,937 | 0.028 | 872,829 | 151,981 | 0.026 | 68,385 | 5,165 | 706 | 138 | 85,066 | 16,375 | 154,157 | 17,171 | 0.44 | 0.05 | 0.18 | 0.04 |
| 2011[l] | 26,877 | 0.026 | 1,026,314 | 162,061 | 0.022 | 34,161 | 2,585 | 1,437 | 289 | 61,099 | 15,747 | 96,698 | 15,961 | 0.35 | 0.06 | 0.09 | 0.02 |
| 2012[m] | 31,092 | 0.024 | 1,229,468 | 242,671 | 0.021 | 27,913 | 2,375 | 398 | 165 | 36,961 | 7,441 | 65,272 | 7,813 | 0.43 | 0.05 | 0.05 | 0.01 |
| 2013[n] | 18,307 | 0.023 | 788,387 | 135,519 | 0.023 | 68,226 | 7,673 | –[o] | –[o] | 51,324 | 9,874 | –[o] | –[o] | –[o] | –[o] | –[o] | –[o] |
| Avg. 2000-2013 | 25,075 | 0.021 | 1,286,773 | 253,223 | 0.020 | 57,270 | 10,060 | 1,780 | 496 | 76,758 | 18,870 | 136,918 | 20,749 | 0.41 | 0.05 | 0.10 | 0.02 |

[a] From Ericksen (2001b).
[b] From Ericksen (2002b).
[c] From Ericksen (2003).
[d] From Ericksen and Chapell (2005).
[e] From Ericksen and Chapell (2006).
[f] From Ericksen (2006).
[g] From Elliott (2009).
[h] From Elliott (2010).
[i] From Elliott (2012a).
[j] From Elliott (2012b).
[k] From Elliott (2013).
[l] From Elliott (*in prep a*).
[m] From Elliott (*in prep b*).
[n] From Elliott (*in prep c*).
[o] Complete estimates for 2013 inriver harvest, marine harvest, and related variances are not yet available.

Table 6.–Number of live coded wire tagged coho salmon released into the Chilkat River by year of release, through 2013.

| Release year | Capture site | Stage | Total marked | Shed tags | Valid tags |
|---|---|---|---|---|---|
| 1976 total | Chilkat River[a] | Parr | 9,074 | 0 | 9,074 |
| 1977 | Chilkat Lake | Parr | 6,344 | 0 | 6,344 |
| 1977 | Chilkat ponds[b] | Parr | 2,729 | 0 | 2,729 |
| 1977 total | | | 9,073 | 0 | 9,073 |
| 1981 total | Chilkat Lake | Parr | 2,603 | 0 | 2,603 |
| 1982 total | Chilkat ponds | Parr | 8,608 | 93 | 8,515 |
| 1984 total | Chilkat ponds | Parr | 14,644 | 102 | 14,542 |
| 1999 | Chilkat River | Smolt | 12,037 | 10 | 12,027 |
| 1999 | Chilkat Lake | Smolt | 4,078 | 0 | 4,078 |
| 1999 | Chilkat tributaries | Smolt | 9,800 | 29 | 9,771 |
| 1999 total | | | 25,915 | 39 | 25,876 |
| 2000 | Chilkat tributaries | Smolt | 9,980 | 20 | 9,960 |
| 2000 | Lower Chilkat River | Smolt | 11,953 | 4 | 11,949 |
| 2000 | Upper Chilkat River | Smolt | 3,083 | 0 | 3,083 |
| 2000 Total | | | 25,016 | 24 | 24,992 |
| 2001 Total | Lower Chilkat River | Smolt | 36,114 | 117 | 35,997 |
| 2002 Total | Lower Chilkat River | Smolt | 25,296 | 7 | 25,289 |
| 2003 Total | Lower Chilkat River | Smolt | 24,563 | 4 | 24,559 |
| 2004 Total | Lower Chilkat River | Smolt | 17,279 | 0 | 17,279 |
| 2005 Total | Lower Chilkat River | Smolt | 26,342 | 16 | 26,326 |
| 2006 Total | Lower Chilkat River | Smolt | 22,168 | 24 | 22,149 |
| 2007 Total | Lower Chilkat River | Smolt | 24,104 | 0 | 24,104 |
| 2008 Total | Lower Chilkat River | Smolt | 23,059 | 0 | 23,059 |
| 2009 Total | Lower Chilkat River | Smolt | 24,937 | 0 | 24,937 |
| 2010 Total | Lower Chilkat River | Smolt | 26,932 | 55 | 26,877 |
| 2011 Total | Lower Chilkat River | Smolt | 31,101 | 9 | 31,092 |
| 2012 Total | Lower Chilkat River | Smolt | 18,353 | 46 | 18,307 |
| 2013 Total | Lower Chilkat River | Smolt | 10,878 | 44 | 10,834 |
| 2014 Total | Lower Chilkat River | Smolt | 8,661 | 0 | 8,661 |
| 2001-2014 Avg. | | | | | 22,819 |

[a] This includes several locations throughout the drainage including the airport tributaries in 1976.
[b] Chilkat ponds refers to several ponds throughout the drainage where fish access was improved.

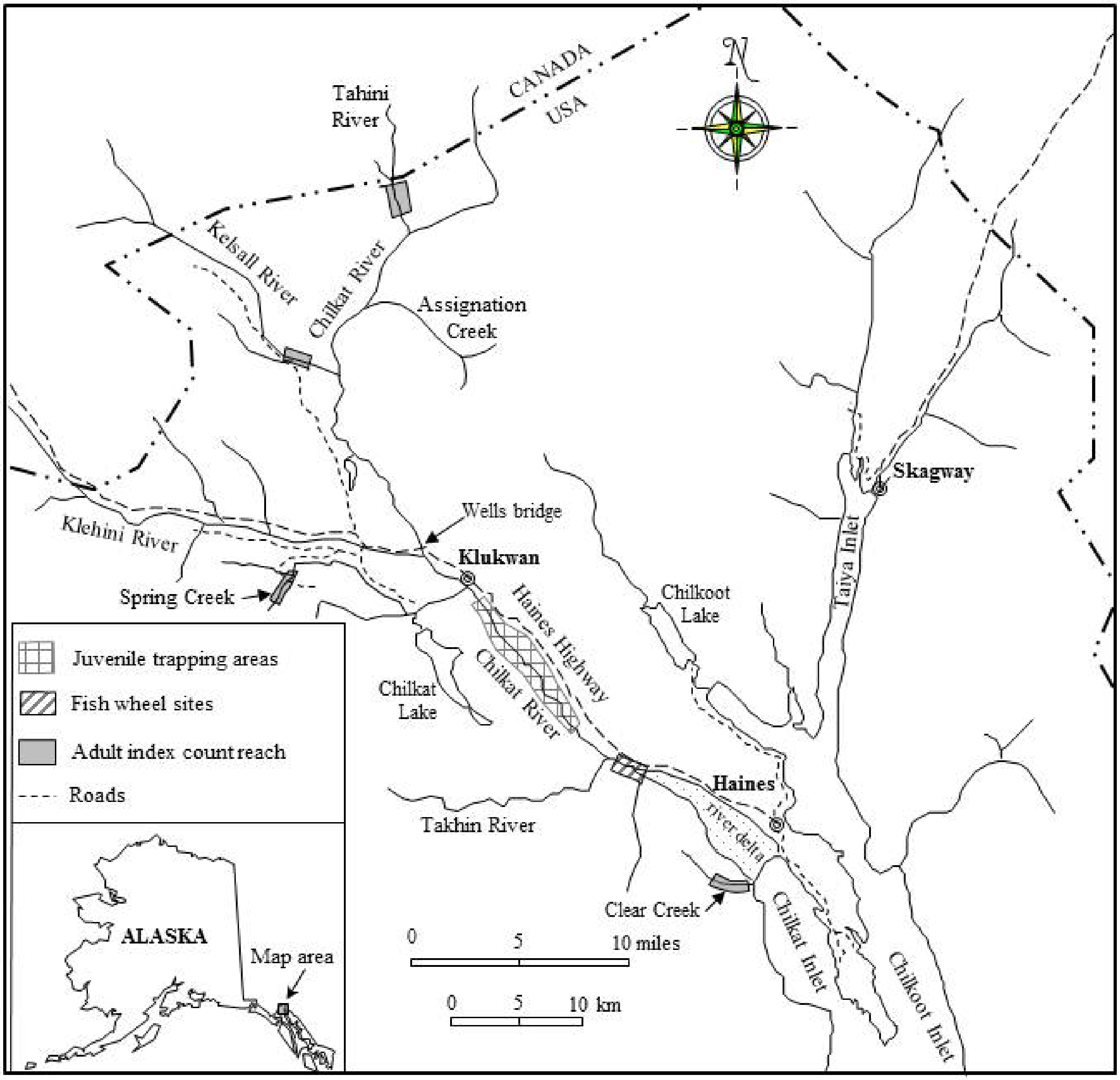


Figure 2.–Coho salmon sampling sites in the Chilkat River drainage in Southeast Alaska.

Table 7.–Peak number of coho salmon counted on spawning index tributaries of the Chilkat River, 1987–2013, compared to mark-recapture estimates for the entire drainage in 1990, 1998, 2002, 2003, and 2005.

| | Peak Surveys | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Spring Ck. | Kelsall R. | Tahini R. | Clear Ck. | Combined ($C_t$) | Estimated Escapement (N^) | SE (N^) | Estimation Method |
| 1987 | 99 | 197 | 792 | 25 | 1,113 | 37,432 | 7,202 | expanded survey |
| 1988 | 87 | 160 | 590 | 40 | 877 | 29,495 | 5,675 | expanded survey |
| 1989 | 57 | 190 | 1,064 | 141 | 1,452 | 48,833 | 9,395 | expanded survey |
| 1990 | 88 | 379 | 2,766 | 150 | 3,383 | 79,807 | 9,980 | mark-recapture |
| 1991 | 176 | 417 | 1,785 | 135 | 2,513 | 84,517 | 16,260 | expanded survey |
| 1992 | 183 | 281 | 1,143 | 700 | 2,307 | 77,588 | 14,927 | expanded survey |
| 1993 | 101 | 129 | 1,041 | 460 | 1,731 | 58,217 | 11,200 | expanded survey |
| 1994 | 451 | 440 | 4,482 | 408 | 5,781 | 194,425 | 37,405 | expanded survey |
| 1995 | 268 | 197 | 1,033 | 189 | 1,687 | 56,737 | 10,916 | expanded survey |
| 1996 | 204 | 179 | 412 | 315 | 1,110 | 37,331 | 7,182 | expanded survey |
| 1997 | 227 | 133 | 684 | 250 | 1,294 | 43,519 | 8,373 | expanded survey |
| 1998 | 271 | 265 | 649 | 275 | 1,460 | 50,758 | 10,698 | mark-recapture |
| 1999 | 335 | 207 | 962 | 195 | 1,699 | 57,140 | 10,993 | expanded survey |
| 2000 | 305 | 571 | 1,324 | 435 | 2,635 | 88,620 | 17,050 | expanded survey |
| 2001 | 450 | 225 | 1,272 | 1,285 | 3,232 | 108,698 | 20,912 | expanded survey |
| 2002 | 1,328 | 440 | 2,582 | 1,310 | 5,660 | 205,429 | 31,165 | mark-recapture |
| 2003 | 500 | 356 | 1,419 | 1,675 | 3,950 | 134,340 | 15,070 | mark-recapture |
| 2004 | 564 | 170 | 827 | 445 | 2,006 | 67,465 | 12,980 | expanded survey |
| 2005 | 221 | 42 | 219 | 495 | 977 | 38,589 | 4,625 | mark-recapture |
| 2006 | 503 | 220 | 761 | 915 | 2,399 | 80,683 | 15,523 | expanded survey |
| 2007 | 55 | 51 | 415 | 237 | 758 | 25,493 | 4,905 | expanded survey |
| 2008 | 337 | 64 | 779 | 526 | 1,706 | 57,376 | 11,039 | expanded survey |
| 2009 | 183 | 159 | 429 | 682 | 1,453 | 48,867 | 9,402 | expanded survey |
| 2010 | 439 | 58 | 1,122 | 1,031 | 2,650 | 89,124 | 17,147 | expanded survey |
| 2011 | 221 | 66 | 882 | 810 | 1,979 | 66,557 | 12,805 | expanded survey |
| 2012 | 164 | 50 | 589 | 347 | 1,150 | 38,677 | 7,441 | expanded survey |
| 2013 | 151 | 13 | 522 | 860 | 1,546 | 51,995 | 10,003 | expanded survey |
| Mean | 295 | 210 | 1,131 | 531 | 2,167 | 72,508 | 14,021 | |
| | | | | | Expansion factor (pi) | 33.6 | | |
| | | | | | SE(pi) | 6.5 | | |

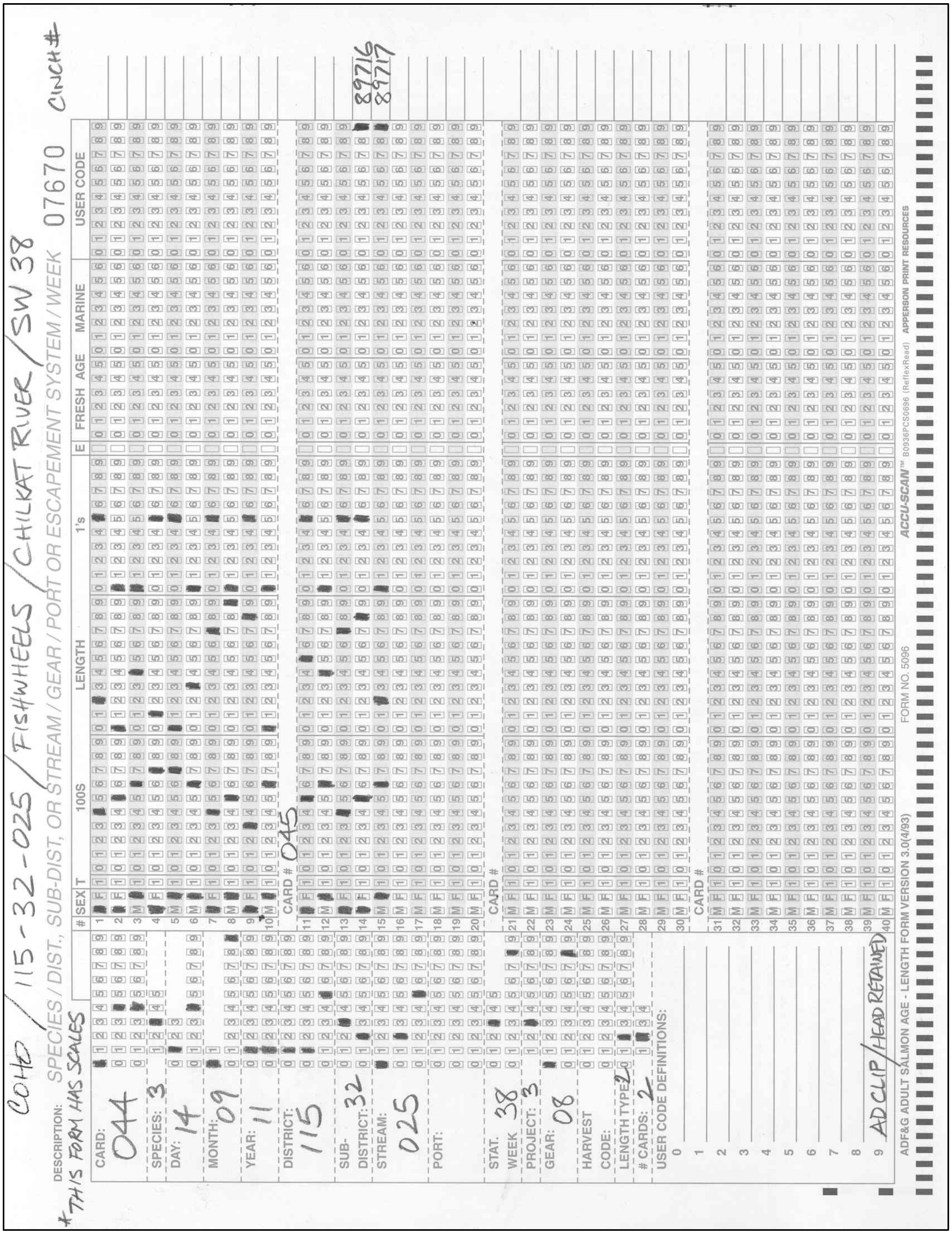


Figure 3.–Example of ADF&G adult salmon age-length form to record sex, length, and scale sample data from the first 13 of 40 coho salmon caught in fish wheels, and from any coho salmon with a clipped adipose fin.

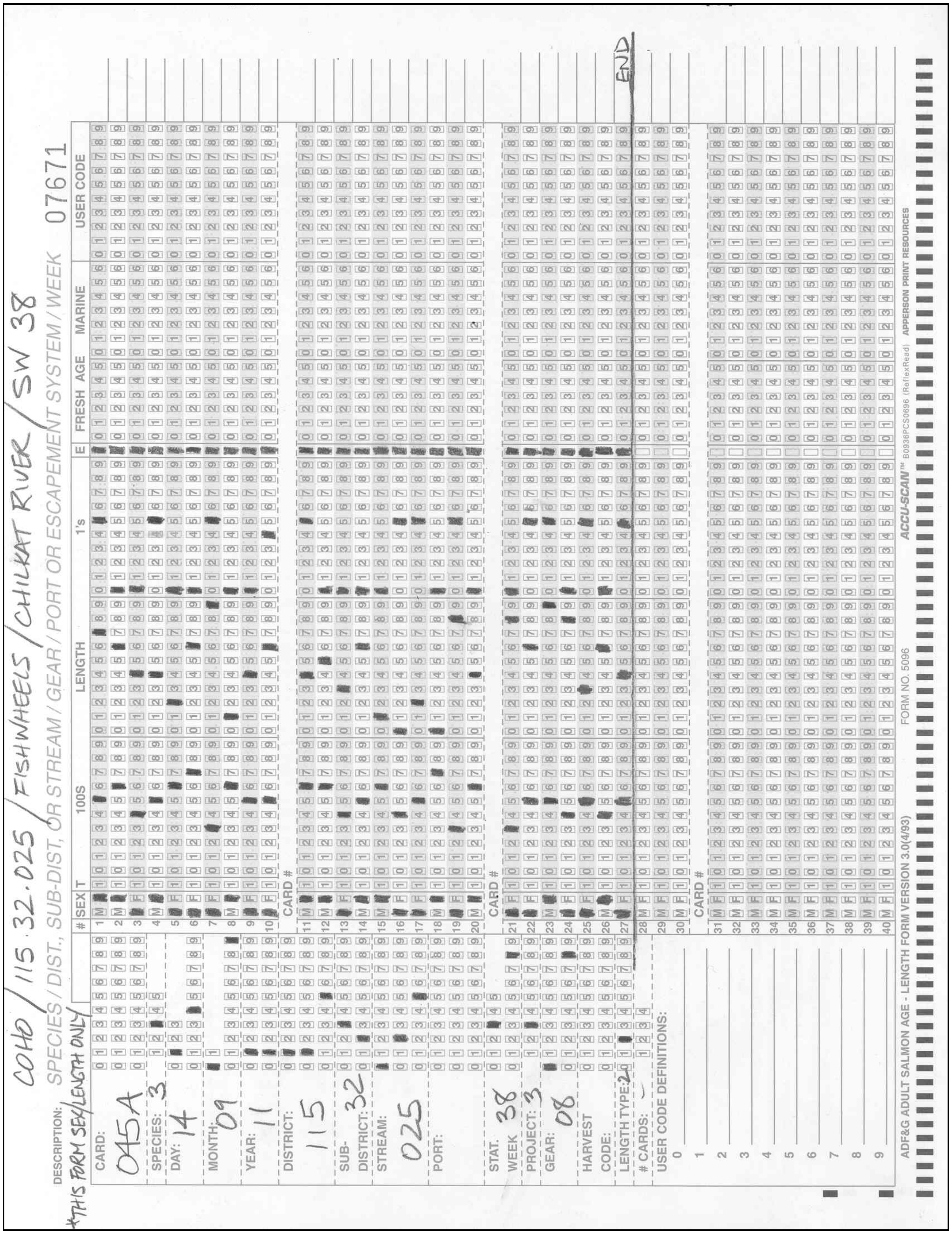


Figure 4.–Example of ADF&G adult salmon age-length form to record sex, length, and scale sample data from the last 27 of 40 coho salmon caught in fish wheels.

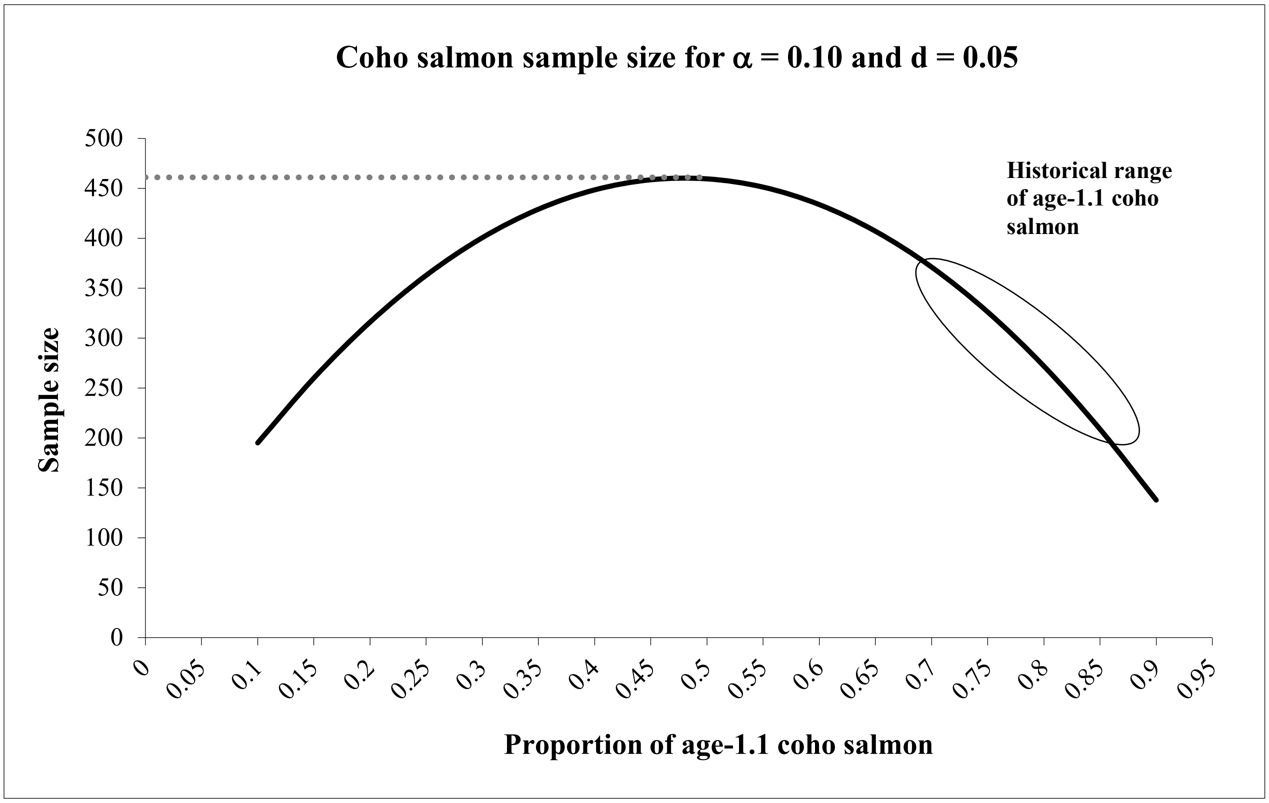


Figure 5.–Maximum number of Chilkat coho salmon smolt scale samples required, from Thompson (2002), based on an alpha value of 0.10 and precision value of 0.05.

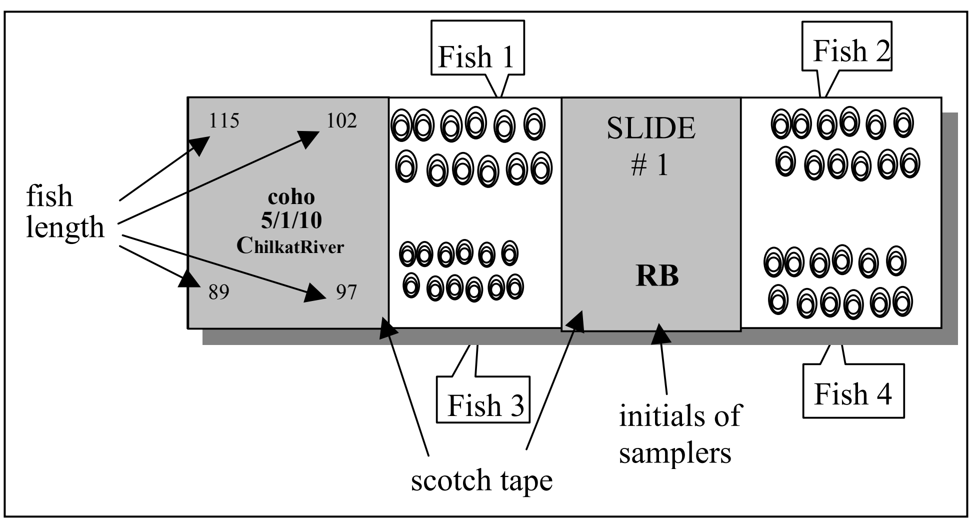


Figure 6.–Preferred microscope slide layout for coho salmon smolt scale samples.

Table 8.–Model results used to determine the effect of non-proportional tagging of parr on the estimate of the overall marked fraction ( ) in the Chilkat River and tributary systems

| $\theta$(area) and estimated $\theta$ (whole river) vs tagging bias | | | | % Difference in $\theta$s | | | |
|---|---|---|---|---|---|---|---|
| Model | θ =Tahini | θ =Kelsall | θ estimate =combined | Absolute difference in areas | % Difference relative to Tahini | % Error in combined | $\chi^2$ Detects difference (p = 0.1) |
| Unbiased | 0.154 | 0.154 | 0.154 | 0.000 | 0 | 0.0 | NA |
| 20% | 0.134 | 0.161 | 0.152 | 0.027 | 20 | -1.1 | No |
| 40% | 0.119 | 0.167 | 0.151 | 0.048 | 40 | -2.0 | No |
| 60% | 0.107 | 0.172 | 0.150 | 0.064 | 60 | -2.7 | No |
| 80% | 0.098 | 0.176 | 0.149 | 0.078 | 80 | -3.3 | Yes |
| 100% | 0.089 | 0.179 | 0.148 | 0.089 | 100 | -3.8 | Yes |
| 120% | 0.082 | 0.181 | 0.147 | 0.099 | 120 | -4.2 | Yes |
| 250% | 0.055 | 0.192 | 0.145 | 0.137 | 250 | -5.8 | Yes |
| 1000% | 0.019 | 0.206 | 0.142 | 0.187 | 1000 | -7.9 | Yes |

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# APPENDIX A

Appendix A1.–Anticipated number of fish released with coded wire tags (CWT) and adipose fin clips in 2015, using the minimum traps deployed (80) and Chinook and coho salmon smolt CPUE from 2013-2014. The most recent two years' CPUE are used because the trap site selection method changed significantly in 2013.

| | | Chinook salmon smolt | | Coho salmon smolt | |
|---|---|---|---|---|---|
| Date | Traps deployed | CPUE 2013-2014 | Valid CWT | CPUE 2013-2014 | Valid CWT |
| 4-Apr | 80 | 1.5 | 118 | 1.8 | 147 |
| 5-Apr | 80 | 2.2 | 176 | 2.6 | 212 |
| 6-Apr | 80 | 2.0 | 158 | 2.5 | 201 |
| 7-Apr | 80 | 1.8 | 147 | 2.5 | 198 |
| 8-Apr | 80 | 1.7 | 139 | 2.5 | 201 |
| 9-Apr | 80 | 1.6 | 132 | 2.6 | 205 |
| 10-Apr | 80 | 1.6 | 128 | 2.6 | 211 |
| 11-Apr | 80 | 1.6 | 125 | 2.7 | 220 |
| 12-Apr | 80 | 1.5 | 122 | 2.9 | 235 |
| 13-Apr | 80 | 1.5 | 119 | 3.1 | 245 |
| 14-Apr | 80 | 1.5 | 117 | 3.1 | 248 |
| 15-Apr | 80 | 1.4 | 114 | 3.1 | 249 |
| 16-Apr | 80 | 1.4 | 111 | 3.0 | 244 |
| 17-Apr | 80 | 1.4 | 109 | 3.0 | 242 |
| 18-Apr | 80 | 1.4 | 109 | 3.1 | 244 |
| 19-Apr | 80 | 1.4 | 108 | 3.1 | 252 |
| 20-Apr | 80 | 1.3 | 105 | 3.2 | 259 |
| 21-Apr | 80 | 1.3 | 104 | 3.3 | 266 |
| 22-Apr | 80 | 1.3 | 100 | 3.3 | 264 |
| 23-Apr | 80 | 1.3 | 102 | 3.3 | 264 |
| 24-Apr | 80 | 1.3 | 105 | 3.3 | 263 |
| 25-Apr | 80 | 1.3 | 106 | 3.3 | 261 |
| 26-Apr | 80 | 1.3 | 105 | 3.2 | 257 |
| 27-Apr | 80 | 1.3 | 104 | 3.2 | 255 |
| 28-Apr | 80 | 1.3 | 104 | 3.2 | 253 |
| 29-Apr | 80 | 1.3 | 104 | 3.1 | 250 |
| 30-Apr | 80 | 1.3 | 106 | 3.1 | 250 |
| 1-May | 80 | 1.3 | 106 | 3.1 | 249 |
| 2-May | 80 | 1.3 | 106 | 3.1 | 247 |
| 3-May | 80 | 1.3 | 107 | 3.1 | 245 |
| 4-May | 80 | 1.3 | 107 | 3.1 | 246 |
| 5-May | 80 | 1.3 | 107 | 3.1 | 246 |
| 6-May | 80 | 1.3 | 106 | 3.1 | 246 |
| 7-May | 80 | 1.3 | 104 | 3.1 | 244 |
| 8-May | 80 | 1.3 | 104 | 3.0 | 244 |
| 9-May | 80 | 1.3 | 103 | 3.1 | 246 |
| 10-May | 80 | 1.3 | 104 | 3.1 | 246 |
| 11-May | 80 | 1.3 | 103 | 3.1 | 245 |
| 12-May | 80 | 1.3 | 101 | 3.1 | 244 |
| 13-May | 80 | 1.2 | 99 | 3.0 | 243 |
| TOTAL | 3,200 | 1.4 | 4,531 | 3.0 | 9,585 |

Appendix A2.–Expected values used in Chilkat Chinook salmon brood year 2013 coded wire tag (CWT) sample size and precision calculations.

| | Survival or harvest rate | Percent of Chilkat marine harvest | Number of Chilkat fish | Marked rate | Number of Chilkat CWT fish | Sampling rate | Number of Chilkat CWTs recovered |
|---|---|---|---|---|---|---|---|
| Fall 2014 parr population | | | 502,127 | | | | |
| Fall 2014 parr marked with CWT | | | | 0.050 | 25,000 | | |
| Spring 2015 survivors | 36.1% | | 175,015 | | 9,025 | | |
| Spring 2015 CWT marked | | | | 0.027 | 4,531 | | |
| Total marked spring 2014 emigrants | | | | 0.077 | 13,556 | | |
| Smolt to adult survivors | 3.0% | | 4,583 | | 355 | | |
| Marine harvest by fishery | | | | | | | |
| Troll | | 17% | 152 | 0.077 | 12 | 0.50 | 6 |
| Gillnet and purse seine | | 32% | 284 | 0.077 | 22 | 0.51 | 8 |
| Sport | | 37% | 322 | 0.077 | 25 | 0.46 | 10 |
| Subsistence | | 14% | 121 | 0.077 | 9 | 0.33 | 3 |
| Total marine harvest | 19.2% | 100% | 879 | 0.077 | 68 | 0.45 | 27 |
| Total inriver abundance | 80.8% | | 3,704 | 0.077 | 287 | 0.14 | 40 |

Appendix A3.–Hypothetical set of marine fishery recoveries of brood year 2013 Chilkat Chinook salmon CWTs used to relate the number of juveniles marked in fall 2014 and spring 2015 to the relative precision of the adult marine harvest estimate.

| | | | Catch | | Harvest | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| District / Fishery | Stat week / Biweek | Age | $N_i$ or $\hat{N}_i$ | $V[\hat{N}_i]$ | $m_i$ | $\lambda_i$ | $\hat{r}_{ij}$ | $\phi_i$ | $G(\hat{p}_i)$ | $G(\hat{N}_i)$ | $V[\hat{r}_{ij}]$ | prob ($m_{ij}$ > 0) |
| 110 Troll | 42 | 1.2 | 410 | 0 | 0.3 | 1.000 | 6 | 56% | 3.64 | 0 | 129 | 0.231 |
| 111 Sport | 17 | 1.2 | 195 | 0 | 0.5 | 0.986 | 11 | 63% | 1.81 | 0 | 217 | 0.409 |
| 112 Purse | 26 | 1.2 | 64 | 0 | 0.3 | 1.000 | 3 | 100% | 3.51 | 0 | 40 | 0.231 |
| 112 Purse | 27 | 1.2 | 118 | 0 | 0.3 | 0.985 | 6 | 54% | 3.65 | 0 | 146 | 0.231 |
| 114 Troll | 24 | 1.2 | 379 | 0 | 0.3 | 0.989 | 6 | 59% | 3.64 | 0 | 122 | 0.231 |
| 114 Troll | 34 | 1.2 | 293 | 0 | 0.3 | 1.000 | 18 | 19% | 3.75 | 0 | 1,161 | 0.231 |
| 115 Drift | 25 | 1.2 | 222 | 0 | 0.5 | 1.000 | 23 | 30% | 1.84 | 0 | 946 | 0.411 |
| 115 Drift | 27 | 1.2 | 152 | 0 | 0.5 | 0.985 | 21 | 33% | 1.84 | 0 | 824 | 0.411 |
| 115 Drift | 28 | 1.2 | 91 | 0 | 0.3 | 0.973 | 10 | 37% | 3.70 | 0 | 330 | 0.231 |
| 115 Drift | 29 | 1.2 | 79 | 0 | 0.3 | 1.000 | 9 | 38% | 3.69 | 0 | 287 | 0.231 |
| 115 Drift | 30 | 1.2 | 56 | 0 | 0.4 | 1.000 | 11 | 44% | 2.45 | 0 | 318 | 0.326 |
| 115 Drift | 31 | 1.2 | 52 | 0 | 0.5 | 1.000 | 13 | 53% | 1.83 | 0 | 301 | 0.409 |
| 115 Drift | 32 | 1.2 | 34 | 0 | 0.3 | 1.000 | 5 | 73% | 3.59 | 0 | 77 | 0.231 |
| 115 Drift | 33 | 1.2 | 31 | 0 | 0.4 | 1.000 | 5 | 96% | 2.35 | 0 | 65 | 0.326 |
| 115 Sport | 24 | 1.2 | 71 | 308 | 0.5 | 1.000 | 19 | 35% | 1.87 | 0.061 | 651 | 0.405 |
| 108 Drift | 27 | 1.3 | 1,340 | 0 | 0.3 | 0.987 | 13 | 26% | 3.73 | 0 | 621 | 0.231 |
| 109 Troll | 22 | 1.3 | 637 | 0 | 0.3 | 0.994 | 6 | 61% | 3.63 | 0 | 111 | 0.231 |
| 113 Troll | 23 | 1.3 | 2,142 | 0 | 0.3 | 0.987 | 8 | 41% | 3.69 | 0 | 253 | 0.231 |
| 114 Troll | 21 | 1.3 | 296 | 0 | 0.7 | 1.000 | 15 | 58% | 1.45 | 0 | 312 | 0.481 |

-continued-

Appendix A3.–Page 2 of 2.

| District / Fishery | Stat week / Biweek | Age | Catch: $N_i$ or $\hat{N}_i$ | Catch: $V[\hat{N}_i]$ | $m_i$ | Harvest: $\lambda_i$ | Harvest: $\hat{r}_{ij}$ | Harvest: $\phi_i$ | $G(\hat{p}_i)$ | $G(\hat{N}_i)$ | $v[\hat{r}_{ij}]$ | prob ($m_{ij}$ > 0) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 114 Troll | 22 | 1.3 | 374 | 0 | 0.4 | 1.000 | 9 | 57% | 2.43 | 0 | 188 | 0.326 |
| 114 Troll | 23 | 1.3 | 380 | 0 | 0.3 | 1.000 | 7 | 48% | 3.66 | 0 | 177 | 0.231 |
| 114 Troll | 24 | 1.3 | 379 | 0 | 1.3 | 0.989 | 29 | 59% | 0.73 | 0 | 622 | 0.731 |
| 114 Troll | 25 | 1.3 | 553 | 0 | 0.4 | 0.980 | 9 | 57% | 2.43 | 0 | 201 | 0.326 |
| 114 Troll | 26 | 1.3 | 343 | 0 | 0.3 | 1.000 | 7 | 50% | 3.66 | 0 | 168 | 0.231 |
| 114 Troll | 27 | 1.3 | 297 | 0 | 0.3 | 1.000 | 12 | 28% | 3.73 | 0 | 556 | 0.231 |
| 115 Drift | 26 | 1.3 | 163 | 0 | 0.8 | 0.918 | 37 | 32% | 1.16 | 0 | 1,596 | 0.568 |
| 115 Drift | 27 | 1.3 | 152 | 0 | 1.2 | 0.985 | 47 | 33% | 0.83 | 0 | 1,861 | 0.693 |
| 115 Drift | 28 | 1.3 | 91 | 0 | 0.8 | 0.973 | 29 | 37% | 1.23 | 0 | 1,002 | 0.546 |
| 115 Drift | 29 | 1.3 | 79 | 0 | 0.8 | 1.000 | 27 | 38% | 1.23 | 0 | 869 | 0.545 |
| 115 Drift | 33 | 1.3 | 31 | 0 | 0.3 | 1.000 | 4 | 96% | 3.52 | 0 | 43 | 0.231 |
| 115 Sport | 11 | 1.3 | 125 | 767 | 1.1 | 0.983 | 24 | 58% | 0.91 | 0.050 | 514 | 0.650 |
| 115 Sport | 12 | 1.3 | 71 | 308 | 2.5 | 1.000 | 91 | 35% | 0.39 | 0.061 | 3,649 | 0.918 |
| 115 Sport | 13 | 1.3 | 10 | 61 | 1.2 | 1.000 | 37 | 41% | 0.82 | 0.574 | 1,295 | 0.693 |
| 115 Subsistence | 25 | 1.3 | 13 | 0 | 0.4 | 1.000 | 19 | 27% | 2.49 | 0 | 901 | 0.326 |
| 115 Subsistence | 26 | 1.3 | 15 | 0 | 0.8 | 1.000 | 20 | 51% | 1.22 | 0 | 490 | 0.545 |
| 115 Subsistence | 27 | 1.3 | 18 | 0 | 1.2 | 1.000 | 57 | 27% | 0.83 | 0 | 2,693 | 0.693 |
| 113 Troll | 21 | 1.4 | 1,444 | 0 | 0.3 | 0.997 | 7 | 46% | 3.67 | 0 | 197 | 0.231 |
| 114 Troll | 22 | 1.4 | 374 | 0 | 0.3 | 1.000 | 6 | 57% | 3.64 | 0 | 125 | 0.231 |
| 114 Troll | 23 | 1.4 | 380 | 0 | 0.3 | 1.000 | 7 | 48% | 3.66 | 0 | 177 | 0.231 |
| 115 Drift | 27 | 1.4 | 152 | 0 | 0.5 | 0.985 | 21 | 33% | 1.84 | 0 | 824 | 0.411 |
| 115 Sport | 11 | 1.4 | 125 | 767 | 1.1 | 0.983 | 24 | 58% | 0.91 | 0.050 | 514 | 0.650 |
| 115 Sport | 12 | 1.4 | 71 | 308 | 2.5 | 1.000 | 91 | 35% | 0.39 | 0.061 | 3,649 | 0.918 |
| 115 Sport | 13 | 1.4 | 10 | 61 | 0.8 | 1.000 | 25 | 41% | 1.23 | 0.574 | 682 | 0.545 |
| 115 Subsistence | 26/27 | 1.4 | 18 | 0 | 0.5 | 1.000 | 25 | 27% | 1.86 | 0 | 1,181 | 0.409 |
| Total | | | 12,328 | | 27 | | 879 | 45% | | | 31,085 | |

Appendix A4.–Simulation data and statistics for anticipating precision of the estimated harvest of Chilkat River coho salmon from marine sport and commercial fisheries in 2016, from an anticipated release in 2015 of 9,585 tagged smolt from a population of 1,286,773. The term $\pi_i$ is the average historical probability (from sampling in 2000–2013) of recovering a tag in a stratum, and $1-(1-\pi_i)^H$ is the anticipated probability recovering a tag in that stratum (i.e., prob(m>0)); see Bernard et al. (1998) for other details.

| **Stratum** (type,area,wks) | **$N_i$** | **Var[$N_i$]** | **$(n_i/N_i)_i$** | **m** | **$\lambda_i$** | **$r_i$** | **se[$r_i$]** | **$\pi_i$** | **$1-(1-\pi i)^H$** |
|---|---|---|---|---|---|---|---|---|---|
| Troll, NW 3 | 489,346 | 0 | 28% | 8.7 | 0.98 | 4,229 | 1,455 | 0.000907 | 1.000 |
| Troll, NE 4 | 62,313 | 0 | 28% | 1.1 | 0.99 | 531 | 503 | 0.000116 | 0.671 |
| Troll, NW 4 | 420,488 | 0 | 35% | 46.3 | 0.98 | 18,285 | 2,913 | 0.004832 | 1.000 |
| Troll, NW 5 | 139,380 | 0 | 28% | 2.0 | 0.99 | 975 | 685 | 0.000212 | 0.869 |
| Sport, Gustavus Ma, 12-18 | 29,636 | 7447441 | 10% | 0.0 | 0.97 | 42 | 243 | 0.000003 | 0.029 |
| Sport, Icy St Ma, 11-18 | 14,927 | 5760978 | 47% | 0.8 | 1.00 | 229 | 255 | 0.000084 | 0.551 |
| Sport, Juneau Ma, 17 | 7,400 | 1120364 | 58% | 0.5 | 0.97 | 116 | 165 | 0.000051 | 0.384 |
| Sport, Juneau Ma, 18-19 | 6,956 | 2503384 | 27% | 0.6 | 0.92 | 327 | 418 | 0.000062 | 0.450 |
| Sport, Sitka Ma, 14 | 9,614 | 11525161 | 24% | 0.0 | 0.97 | 17 | 92 | 0.000003 | 0.029 |
| Sport, Sitka Ma, 17 | 18,032 | 6062031 | 30% | 0.1 | 0.97 | 39 | 133 | 0.000009 | 0.081 |
| Sport, Yakutat Ma, 16-18 | 5,484 | 1394020 | 65% | 0.2 | 1.00 | 44 | 93 | 0.000022 | 0.191 |
| Gillnet, 111, 38 | 10,901 | 0 | 15% | 0.1 | 0.98 | 51 | 217 | 0.000006 | 0.054 |
| Gillnet ,115, 34 | 1,990 | 0 | 34% | 0.8 | 1.00 | 319 | 354 | 0.000085 | 0.556 |
| Gillnet, 115, 35 | 3,839 | 0 | 46% | 3.2 | 0.96 | 970 | 546 | 0.000331 | 0.958 |
| Gillnet,115, 36 | 6,786 | 0 | 29% | 6.4 | 1.00 | 2,969 | 1,187 | 0.000665 | 0.998 |
| Gillnet, 115, 37 | 10,040 | 0 | 22% | 5.7 | 0.99 | 3,521 | 1,482 | 0.000599 | 0.997 |
| Gillnet, 115, 38 | 11,900 | 0 | 21% | 5.2 | 0.97 | 3,449 | 1,522 | 0.000544 | 0.995 |
| Gillnet, 115, 39 | 8,451 | 0 | 32% | 11.3 | 0.98 | 4,864 | 1,473 | 0.001182 | 1.000 |
| Gillnet, 115, 40-41 | 3,694 | 0 | 36% | 4.8 | 0.99 | 1,812 | 832 | 0.000501 | 0.992 |

-continued-

Appendix A4.–Page 2 of 2.

| **Stratum** (type,area,wks) | $N_i$ | $Var[N_i]$ | $(n_i/N_i)_i$ | m | $\lambda_i$ | $r_i$ | $se[r_i]$ | $\pi_i$ | $1-(1-\pi i)^H$ |
|---|---|---|---|---|---|---|---|---|---|
| Seine, 109, 31 | 44,672 | 0 | 13% | 0.0 | 0.99 | 31 | 181 | 0.000003 | 0.029 |
| Seine, 109, 32 | 9,660 | 0 | 22% | 0.0 | 0.99 | 26 | 125 | 0.000004 | 0.042 |
| Seine, 112, 30 | 6,455 | 0 | 15% | 0.1 | 0.99 | 92 | 284 | 0.000011 | 0.099 |
| Seine, 112, 31 | 6,555 | 0 | 32% | 0.0 | 0.99 | 18 | 86 | 0.000004 | 0.042 |
| Seine, 112, 33 | 2,284 | 0 | 80% | 0.1 | 0.99 | 15 | 50 | 0.000009 | 0.082 |
| Seine, 112, 34 | 11,911 | 0 | 40% | 0.3 | 0.99 | 84 | 168 | 0.000026 | 0.222 |
| Seine, 112, 35 | 15,508 | 0 | 16% | 0.1 | 0.99 | 71 | 241 | 0.000009 | 0.082 |
| Seine, 114, 31 | 6,377 | 0 | 53% | 0.0 | 0.99 | 8 | 44 | 0.000003 | 0.029 |
| Seine, 114, 34 | 1,136 | 0 | 26% | 0.0 | 1.00 | 21 | 104 | 0.000004 | 0.040 |
| Seine, 114, 38 | 1,993 | 0 | 21% | 0.1 | 1.00 | 55 | 189 | 0.000009 | 0.081 |
| Total | 1,367,726 | 35,813,379 | 30% | 99 | | 43,211 | 4,606 | **90% r.p.=17.5%** | 0.000 |

Appendix A5.–WinBUGS code and results of Bayesian statistical analysis of BY 2005 juvenile Chinook River salmon abundance.

data from other recoveries included, non-valid tags considered

prior distributions for root nodes in italics

fixed constants in bold

deterministic relationships in black (these link the priors and the likelihoods, or calculate auxiliary quantities)

likelihood (sampling distribution of data) underlined

2005 BY constants

**adclips <- 70** **# ad clips found**

**heads <- 45** **# heads collected (this is actually not relevant here)**

**valid.tags <- 44** **# tags decoded**

model {

*N.parr ~ dnorm(0,1.0E-12)* *# abundance of parr in fall*

*phi.1 ~ dbeta(0.1,0.1)* *# proportion of parr surviving until spring*

*rho ~ dbeta(0.1,0.1)* *# proportion of ad clipped fish for which head collected and tag decoded*

**M.parr <- 18,318** **# parr marked**

**M.smolt <- 2,238** **# smolt marked**

**C <- 814** **# fish inspected inriver for ad clips**

**m<-20** **# number of Chilkat CWT recoveries elsewhere, fall and spring**

N.smolt <- N.parr * phi.1 # abundance of smolt the following spring

q.fall <- M.parr / N.parr # fraction marked in fall

q.spring <- M.smolt / N.smolt # fraction marked in spring

pi[1] <- q.fall * rho # fraction of returning fish from which could expect a valid fall tag

pi[2] <- q.spring * rho # fraction of returning fish from which could expect a valid spring tag

pi[3] <- (q.fall + q.spring) * (1 - rho) # fraction of returning fish with adclip, but no valid tag

pi[4] <- 1 - pi[1] - pi[2] - pi[3] # fraction with no adclip

<u>R.tags[1:4] ~ dmulti(pi[],C)</u> <u># vector of returns by type is multinomially distributed</u>

pi.fall <- q.fall / (q.fall + q.spring) # fraction of fall tags among all Chilkat tags

<u>m.fall ~ dbin(pi.fall,m)</u> <u># number of fall tags among Chilkat tags is binomially distributed</u>

DATA

list(R.tags=c(39,5,26,743),m.fall=18) # terms in DATA list are:39 fall tags in Chilkat escapement,
# 5 spring tags in Chilkat escapement; 26 heads not taken or
# tags not decoded; 743 fish with intact adipose fins;
# 18 fall tags recovered in marine random samples.

INITS

list(N.parr =239000, phi.1=0.6, rho=0.6)

RESULTS

| node | mean | sd | MC error | 2.50% | 10.00% | median | 90.00% | 97.50% | start | sample |
|---|---|---|---|---|---|---|---|---|---|---|
| N.parr | 249,100 | 29,570 | 135 | 198,500 | 213,500 | 246,700 | 288,000 | 313,900 | 4,001 | 96,000 |
| N.smolt | 222,900 | 38,530 | 158 | 140,300 | 171,800 | 224,800 | 269,600 | 295,300 | 4,001 | 96,000 |
| phi.1 | 0.8976 | 0.1295 | 6.55E-04 | 0.5515 | 0.6955 | 0.9569 | 0.9998 | 1.0000 | 4,001 | 96,000 |
| pi[1] | 0.0468 | 0.0070 | 2.58E-05 | 0.0341 | 0.0382 | 0.0465 | 0.0559 | 0.0613 | 4,001 | 96,000 |
| pi[2] | 0.0065 | 0.0015 | 5.28E-06 | 0.0045 | 0.0050 | 0.0063 | 0.0083 | 0.0102 | 4,001 | 96,000 |
| pi[3] | 0.0316 | 0.0061 | 1.79E-05 | 0.0208 | 0.0240 | 0.0312 | 0.0396 | 0.0446 | 4,001 | 96,000 |
| rho | 0.6282 | 0.0575 | 1.07E-04 | 0.5125 | 0.5533 | 0.6295 | 0.7013 | 0.7369 | 4,001 | 96,000 |

# APPENDIX B

**Appendix B1.**–Smolt coded wire tag daily log.

***Tagging Site:*** Chilkat River

***Species:*** Coho

***Capture Site:*** Chilkat River

**Tagger: Derby**

**Date: May 5, 2013**

***Today's Tagging:*** Machine Serial No.___621___________

| | SMALL | MEDIUM | LARGE |
|---|---|---|---|
| Tag Code | 04-18-93 | 04-18-94 | 04-18-94 |
| End # | 276,633 | 275,822 | 276,204 |
| Start # | 276,209 | 275,513 | 275,824 |
| Subtotal | 424 | 309 | 380 |
| Double/Retags | 0 | 2 | 12 |
| **Total Tagged** | 424 | 307 | 368 |

***Today's Recaptures:***

| | |
|---|---|
| Total w/o CWTs | 29 |
| Total w/ CWTs | 0 |
| Total | 29 |

***Tag Retention & Mortality Calculations (hold until next day):***

| | |
|---|---|
| No. w/ CWTs | 100 |
| No. w/o CWTs | 0 |
| No. Tested | 100 |

| ***Summary*** | # valid tagged | overnight mortality | # released |
|---|---|---|---|
| 75–84mm | 424 | 1 | 423 |
| 85–99mm | 307 | 0 | 307 |
| >=100mm | 368 | 2 | 366 |
| TOTAL | 1099 | 3 | 1096 |

Appendix B2.–Instructions for juvenile salmon trapping.

Traps will be tied off with an overhand knot followed by a slipknot to insure traps can be pulled quickly during floodwaters. Try to tie off well above the water level in case of rising water. Always push flagging up to the knot and place extra flagging if not easily visible. Cinch the knot on the flagging tape tight so wind won't blow it into the water. Always carry extra flagging and use it if traps are in hard to find locations.

One crew leader will be in charge of a trap line, and the other will be in charge of the other trap line. Keep accurate track of all traps. **REMEMBER**: <u>Lost traps keep fishing and kill fish</u>. Count all traps taken out to the field at the beginning of the season and record this number in the logbook. If more traps are taken to the field later on, these need to be recorded as well. All lost or damaged traps (i.e., bear hits) will be recorded, and the damaged traps kept in a certain place until the end of the season. The goal is to be able to reconcile the number of traps we have upon pulling out from an area with the number taken out to the field, as even one trap potentially left set is a problem. Also in early–mid May, eulachon will be running in the lower river. Be sensitive to people fishing for eulachon. It may be best to stay out of the lower river during this time.

Both crews should take hand counters to help keep track of the number of traps on the longer lines. If a trap is lost during high water, it should be marked as lost in the trap-line book and the area flagged so the trap may be recovered at low water.

Name specific areas of the river where you are trapping. Naming an area after a natural feature will help you associate the area with the name. Examples are Spruce Row, Moose Bar and Big Beaver. So that everyone is using a standard method of notation in the trap-line field book, the format will be as follows:

Table 1.–Example of data collected and recorded in the field during smolt trapping efforts on the Unuk River in Fall, 2003.

| Date: 10/20/2003 | | | | | |
|---|---|---|---|---|---|
| Site | Traps checked | Traps pulled | Traps added | Total traps | # Of fish by species |
| Spruce Row | 5 | 2 | 0 | 3 | 30 coho; 10 king |
| Moose Bar | 2 | 0 | 2 | 4 | 50 coho |
| Big Beaver | 3 | 3 | 0 | 0 | 5 coho |
| Snowball | 0 | 0 | 3 | 3 | New sets |
| Total | 10 | 5 | 5 | 10 | 85 coho; 10 king |

According to the above notation, at Spruce Row we checked 5 traps; two of the traps didn't catch many fish so we pulled them. That leaves us with 3 traps in that area and we caught approximately 30 fish there. On Moose Bar we checked 2 traps and caught 50 fish so we set 2 more in that area, for a total of 4 traps in the water. At Big Beaver we checked 3 traps for a total of 5 fish, lousy fishing so we pulled all 3 traps, leaving us with 10 traps in that area. We set 3 traps in a new area called Snowball. Looking at the total we see that we caught 85 coho and 10 kings that day and have 10 traps still in the water fishing.

The rest of the crew will alternate between upriver and downriver to break up the monotony of always working with the same person.

The number of traps out is the important number. Don’t waste a lot of time counting each individual fish. We will get the exact number when we tag. Be conservative in your counting. The objective is to tag a lot of fish, not to have a higher number in your book than the other crew.

Appendix B3.–Minnow trap summary form. A7

| | River | River | Lower Trapline | | | | Upper Trapline | | | | Daily Total | | | | Cum. Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Depth | Temp | Number of traps | | Est. Fish | | Number of traps | | Est. Fish | | Est. Fish | | # Tagged | | # Tagged | # Tagged |
| Date | (in) | (C) | Checked | Set | Chinook | Coho | Checked | Set | Chinook | Coho | Chinook | Coho | Chinook | Coho | Chinook | Coho |
| 8-Apr | 6.00 | 2.0 | | 50 | | | | 40 | | | | | | | | |
| 9-Apr | 6.50 | 2.0 | 50 | 44 | 37 | 144 | 40 | 50 | 48 | 285 | 85 | 429 | | | | |
| 10-Apr | 7.00 | 2.0 | 44 | 40 | 39 | 201 | 50 | 36 | 39 | 432 | 78 | 633 | 160 | 1,162 | 160 | 1,162 |
| 11-Apr | 7.25 | 3.0 | 40 | 46 | 26 | 118 | 36 | 47 | 39 | 284 | 65 | 402 | | | | |
| 12-Apr | 8.00 | 3.0 | 46 | 35 | 9 | 120 | 47 | 42 | 29 | 218 | 38 | 338 | 85 | 658 | 245 | 1,820 |
| 13-Apr | 10.00 | 3.0 | 35 | 36 | 6 | 64 | 42 | 47 | 35 | 231 | 41 | 295 | | | | |
| 14-Apr | 11.50 | 3.0 | 36 | 50 | 28 | 85 | 47 | 47 | 24 | 221 | 52 | 306 | 74 | 553 | 319 | 2,373 |
| 15-Apr | 13.50 | 2.5 | 50 | 46 | 23 | 91 | 47 | 50 | 8 | 180 | 31 | 271 | | | | |
| 16-Apr | 14.50 | 3.0 | 46 | 43 | 28 | 277 | 50 | 49 | 11 | 174 | 39 | 451 | 69 | 666 | 388 | 3,039 |
| 17-Apr | 16.25 | 3.0 | 43 | 46 | 33 | 188 | 49 | 49 | 37 | 238 | 70 | 426 | | | | |
| 18-Apr | 16.75 | 2.5 | 46 | 40 | 21 | 144 | 49 | 49 | 84 | 311 | 105 | 455 | 138 | 714 | 526 | 3,753 |
| 19-Apr | 17.00 | 3.0 | 40 | 48 | 33 | 174 | 49 | 50 | 66 | 231 | 99 | 405 | | | | |
| 20-Apr | 18.00 | 4.0 | 48 | 46 | 40 | 290 | 50 | 50 | 49 | 193 | 89 | 483 | 203 | 772 | 729 | 4,525 |
| 21-Apr | 19.00 | 3.0 | 46 | 46 | 51 | 216 | 50 | 50 | 39 | 145 | 90 | 361 | | | | |
| 22-Apr | 19.00 | 3.0 | 46 | 46 | 26 | 201 | 49 | 49 | 68 | 171 | 94 | 372 | 150 | 389 | 879 | 4,914 |
| 23-Apr | 19.25 | 2.5 | 46 | 48 | 12 | 143 | 49 | 48 | 48 | 270 | 60 | 413 | | | | |
| 24-Apr | 19.25 | 3.0 | 48 | 47 | 22 | 140 | 48 | 48 | 59 | 263 | 81 | 403 | 129 | 649 | 1,008 | 5,563 |
| 25-Apr | 19.00 | 3.0 | 47 | 47 | 37 | 143 | 48 | 48 | 74 | 222 | 111 | 365 | | | | |
| 26-Apr | 19.00 | 3.0 | 47 | 46 | 43 | 147 | 48 | 48 | 88 | 174 | 131 | 321 | 222 | 653 | 1,230 | 6,216 |
| 27-Apr | 19.00 | 3.0 | 46 | 48 | 65 | 184 | 48 | 48 | 114 | 256 | 179 | 440 | | | | |
| 28-Apr | 20.75 | 4.0 | 48 | 49 | 49 | 134 | 48 | 48 | 146 | 198 | 195 | 332 | 382 | 675 | 1,612 | 6,891 |
| 29-Apr | 21.00 | 4.0 | 49 | 49 | 79 | 167 | 48 | 48 | 95 | 206 | 174 | 373 | | | | |
| 30-Apr | 22.00 | 4.0 | 49 | 49 | 50 | 157 | 48 | 48 | 142 | 292 | 192 | 449 | 357 | 577 | 1,969 | 7,468 |
| 1-May | 22.00 | 4.0 | 49 | 45 | 58 | 96 | 48 | 46 | 147 | 321 | 205 | 417 | | | | |
| 2-May | 22.75 | 4.0 | 45 | 46 | 94 | 146 | 46 | 50 | 88 | 241 | 182 | 387 | 373 | 775 | 2,342 | 8,243 |
| 3-May | 23.00 | 4.0 | 46 | 50 | 93 | 207 | 50 | 50 | 54 | 208 | 147 | 415 | | | | |
| 4-May | 23.00 | 4.0 | 50 | 50 | 57 | 173 | 50 | 49 | 41 | 265 | 98 | 438 | 232 | 748 | 2,574 | 8,991 |
| 5-May | 22.75 | 4.0 | 50 | 50 | 20 | 139 | 49 | 48 | 37 | 309 | 57 | 448 | | | | |
| 6-May | 23.00 | 4.0 | 50 | 50 | 25 | 266 | 48 | 48 | 37 | 222 | 62 | 488 | 88 | 767 | 2,662 | 9,758 |
| 7-May | 24.00 | 4.5 | 50 | 50 | 18 | 239 | 48 | 49 | 34 | 263 | 52 | 502 | | | | |
| 8-May | 26.75 | 4.0 | 50 | 50 | 14 | 133 | 49 | 49 | 40 | 222 | 54 | 355 | 104 | 737 | 2,766 | 10,495 |
| 9-May | 26.00 | 3.5 | 50 | 50 | 7 | 262 | 49 | 49 | 64 | 285 | 71 | 547 | | | | |
| 10-May | 24.50 | 4.0 | 50 | 50 | 6 | 146 | 49 | 49 | 47 | 238 | 53 | 384 | 108 | 727 | 2,874 | 11,222 |
| 11-May | 24.50 | 4.5 | 50 | 49 | 17 | 209 | 49 | 49 | 27 | 269 | 44 | 478 | | | | |
| 12-May | 27.00 | 4.0 | 49 | 49 | 8 | 176 | 49 | 49 | 25 | 220 | 33 | 396 | 64 | 740 | 2,938 | 11,962 |
| 13-May | 27.75 | 4.0 | 49 | 49 | 18 | 192 | 49 | 49 | 15 | 244 | 33 | 436 | | | | |
| 14-May | 26.50 | 4.5 | 49 | 48 | 24 | 207 | 49 | 49 | 12 | 282 | 36 | 489 | 67 | 801 | 3,005 | 12,763 |

Appendix B4.–Chilkat River Chinook salmon sampling form.

Gear:        Location:

| **Fish #** | **Date** | **Length** | **Fish #** | **Date** | **Length** |
|---|---|---|---|---|---|
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Appendix B5.–Chilkat River coho salmon smolt age-weight-length form.

**Location:** ______________ **Year:** ________

**Species:** ______________ **Page :** ________

**Samplers:**

| Date | Slide | Fish # | Length | Weight | Comments | Date | Slide | Fish # | Length | Weight | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| | | 1 | | | | | | 1 | | | |
| | | 2 | | | | | | 2 | | | |
| | | 3 | | | | | | 3 | | | |
| | | 4 | | | | | | 4 | | | |
| | | | | | | | | | | | |
| | | 1 | | | | | | 1 | | | |
| | | 2 | | | | | | 2 | | | |
| | | 3 | | | | | | 3 | | | |
| | | 4 | | | | | | 4 | | | |
| | | | | | | | | | | | |
| | | 1 | | | | | | 1 | | | |
| | | 2 | | | | | | 2 | | | |
| | | 3 | | | | | | 3 | | | |
| | | 4 | | | | | | 4 | | | |
| | | | | | | | | | | | |
| | | 1 | | | | | | 1 | | | |
| | | 2 | | | | | | 2 | | | |
| | | 3 | | | | | | 3 | | | |
| | | 4 | | | | | | 4 | | | |
| | | | | | | | | | | | |
| | | 1 | | | | | | 1 | | | |
| | | 2 | | | | | | 2 | | | |
| | | 3 | | | | | | 3 | | | |
| | | 4 | | | | | | 4 | | | |
| | | | | | | | | | | | |
| | | 1 | | | | | | 1 | | | |
| | | 2 | | | | | | 2 | | | |
| | | 3 | | | | | | 3 | | | |
| | | 4 | | | | | | 4 | | | |
| | | | | | | | | | | | |

Appendix B6.–Coded wire tag online release entry report.

## CWT Online Release Entry Final Notification, Tag Code: 041546

Tag Code: 041546 | Beg. Seq.: | End. Seq.:

### General Information

| | | | | | |
|---|---|---|---|---|---|
| Project Leader: | RICHARD CHAPELL | Species: | COHO | Rearing Type: | WILD |
| Agency: | ADFG | Brood Year: | 2007 | Release Type: | |
| Division/Section: | SPORT FISH | Stock: | CHILKAT RIVER | Run: | SUMMER |
| Facility: | | Ancestral Stock: | | Mark Type Code: | AD |
| Experimental Class: | | | | Thermal Mark: | |

Experimental Narrative: 250 characters max.

WILD COHO SALMON (SIZE RANGE >=85MM FROM BY2006 AND BY2007) CAUGHT, TAGGED, AND RELEASED IN THE CHILKAT RIVER 5/16/2009 - 5/30/2009. TAG RETENTION PERFORMED ON MIXED SAMPLE OF FISH; SAMPLE SIZE PROPORTIONED ACCORDINGLY.

Statistical Replicates:

### Tagging Information

Tagging Supervisor: LARRY DERBY | Size of Tagged Fish: grams | Naturally Missing Ad Fins:

| Date | Mach. Number | Number Injected | Overnight Mortality | Adj. Tagged | Tag Retention Sample Ratio | % Tag Retention | Valid Tagged |
|---|---|---|---|---|---|---|---|
| 5/16/2009 | 621 | 691 | 2 | 689 | 50 / 50 | 100.0% | 689 |
| 5/18/2009 | 621 | 727 | 1 | 726 | 50 / 50 | 100.0% | 726 |
| 5/20/2009 | 621 | 778 | 6 | 772 | 50 / 50 | 100.0% | 772 |
| 5/22/2009 | 621 | 1,121 | 17 | 1,104 | 50 / 50 | 100.0% | 1,104 |
| 5/24/2009 | 621 | 913 | 4 | 909 | 50 / 50 | 100.0% | 909 |
| 5/26/2009 | 621 | 944 | 18 | 926 | 50 / 50 | 100.0% | 926 |
| 5/28/2009 | 621 | 517 | 1 | 516 | 50 / 50 | 100.0% | 516 |
| 5/29/2009 | 621 | 271 | 2 | 269 | 50 / 50 | 100.0% | 269 |

| | | | | | |
|---|---|---|---|---|---|
| Total Number Injected: | 5,962 | Total Overnight Morts: | 51 | Total Adjusted Tagged: | 5,911 |
| Average Tag Retention: | 100.0% | Total Retention Sample: | 400 | Total Valid Tagged: | 5,911 |

### Release Information

| | | | |
|---|---|---|---|
| Release Supervisor: | BRIAN ELLIOTT | Release Stage: | SMOLT |
| Release Site: | CHILKAT RIVER | Unmarked Counting Method: | |
| Stream #: | 115-32-10250-% | Expected Survival: | NORMAL |
| Time of Release (Military Format): | 0900 | Release Strategy: | |

| Release Dates: Began | Release Dates: Ended | Date of Final Tag Retention Test | Tag Retention Sample Ratio | % Tag Retention | Size at Release: Weight | Size at Release: Fork Length |
|---|---|---|---|---|---|---|
| 5/17/2009 | 5/30/2009 | 5/30/2009 | 50 / 50 | 100.0% | | |

| Total injected | Overnight morts | Morts after tagging | Surviving tagged fish | Tag retention best estimate |
|---|---|---|---|---|
| 5,962 | 51 | | 5,911 | 100.0% |

| Marked Fish Having Tags | Marked Fish That Shed Tags | Fish Released NOT Marked but Represented | Failed Marks | Total Unmarked Fish Released | Total Fish Released | Tag Ratio |
|---|---|---|---|---|---|---|
| 5,911 | 0 | | 0 | | 5,911 | 1.000 |

Comments: 250 characters max.

WILD COHO SALMON SMOLT TAGGED IN "MEDIUM" AND "LARGE" CATEGORY (SIZE >=85MM FROM BY2006 AND BY2007), SEPARATE FROM SMALL (>=75MM - <85MM) COHO SALMON SMOLT

# APPENDIX C

Appendix C1.–Global positioning system data collection protocol.

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**Overview of the Global Positioning System (GPS)**

The Global Positioning System (GPS) is a world-wide radio-navigation system formed from a constellation of 24 satellites with precise atomic clocks orbiting 11,000 km above the earth's surface, and their associated ground stations. Positions on earth are determined by receiving the radio signals being emitted, and measuring the very precise distances and time to the available satellite(s); the process uses mathematical 'triangulation' calculations to compute the result.

Essentially, four visible satellites are necessary to accurately determine position, but three available satellites can do the same—albeit sometimes less reliably, depending on their constellation/configuration at that specific point in time. The steep terrain associated with certain parts of Alaska will at times present problems with obstructed views of the sky and therefore will play a role in how well the radio signals from the satellites are being received. However, use of external antennas, leaving units turned on over the course of the day while surveying, and waiting until certain times of day to collect data can all enhance ones ability to collect reasonably precise positions.

**GPS Instrument Setup**

There are a myriad of makes and models of consumer-grade GPS units available for purchase, but in the end, they all process and produce positional data the same. Before GPS units can be used for navigation or waypoint storage purposes, they need to be initialized. Each GPS receiver should only need to be initialized the first time the unit is used, or if it has been stored for several months or moved a substantial distance while turned off. The initialization procedure is automatic for most GPS receivers and begins on power-up. To initialize a unit for the first time, take the GPS receiver outside with a clear, 360 degree field of view and turn it on. Navigate through the 'pages' of the GPS using the LCD display until the unit shows that it is acquiring satellites. The unit will begin acquiring fixes on available satellites, and storing the orbital data for each in an almanac in memory on the unit. This setup should complete the initialization of the unit.

There are two key items to remember when using consumer-grade GPS units relative to coordinate data being saved/recorded: 1) coordinate information stored directly on the unit (as waypoints or routes) is always stored in a world geographic coordinate system (WGS84) datum and cannot be overridden until they are downloaded; and 2) you can override the datum and projection being displayed on the screen using the setup menu as necessary, <u>but it is important to document what you set the datum/projection to (i.e. NAD83 Stateplane Alaska Zone 1)</u> if recording those coordinates onto a data form/book rather than saving as waypoints on the unit—this is imperative to ensure correct display in GIS for rendering final output.

Observers should always attempt to get the best possible "fix" from satellites when taking a GPS reading. Often, fixes with accuracy (or error, as it is labeled with some GPS units) under 15 m are possible in less than 30 seconds, especially on the larger river systems where canopy cover is minimal, and the view of the horizon is not obscured (e.g., high ridge immediately above river bank). There will be days when the constellation of the satellites is insufficient to allow for good fixes (i.e., >15 m accuracy); in these instances, it is preferred that GPS locations be acquired on a return visit. If no return visit is anticipated, then observers should spend an extra 1–2min, if possible, to let the GPS instrument acquire the best fix under the circumstances.

**Importance of Spatial Data to Fisheries Management and Research**

Like many resource management agencies across the country, the Alaska Department of Fish and Game's mission is to protect, maintain and improve the fish, game and aquatic plant resources of the state. And almost everything that is done in our day-to-day activities, or conveyed to the public, is explicit to somewhere on the landscape. For example, research project plans typically describe specific locations where data need to be collected; news releases typically describe where users may or may NOT harvest resources, etc. Yet there is no standardized way to document where exactly these places are across the landscape and worse yet, no data management system to accommodate that type of information. Our intent is to layout some guidelines that can be used by others to assist in their spatial data collection efforts.

Spatial data when added to fish observation data is a very useful tool, and can help facilitate a number of information needs for enhancing our ability to carry out the mission of the Department. Examples include: increasing our knowledge of fish distribution for purposes of protection and conservation; documenting where boundary markers are established for fishery openings; documenting where fish are trapped/observed during sampling events for return trips; use of site-specific fish locations to develop landscape-based models that estimate fish production; identifying areas on the landscape that are most important to users for purposes of conservation and protection.

**GPS Data Collection Procedures for use in Salmon Stock Assessment Projects**

**Smolt Tagging (Fall, Spring)**

This section will describe the development and implementation of procedures and techniques for the collection of spatial data using GPS units at specific locations on the ground associated with smolt trapping sites on several Transboundary River Systems. These projects include coded wire tagging of Chinook and coho salmon presmolts and smolts which is a component of full stock assessment projects.

First and foremost, SF crews are NOT being asked to change their mode of operations, as it pertains to smolt trapping methods. Rather, the collection of spatial data using GPS units (waypoints) should be considered a task that occurs coincidentally with their delegated smolt trapping work. Generally, you will be looking to collect waypoints at smolt-trapping sites to generally describe the extent of the smolt-trapping area. For example, if we knew that trapping sites were all the same size and configuration, we could simply grab one waypoint for a group of traps known collectively to encompass site 'X'. However, the reality is that these trapping sites differ in size and configuration and migrate upstream/downstream as water levels rise and fall across the trapping season. The general practice is that vernacular names are assigned to these trapping areas in a given season, and rather than re-naming those areas where traps are moved only short distances, typically retain the same name. In other instances, SF crews move into new areas as snow/ice dissipate, at which time the area is assigned a new generic name.

Capturing waypoints in a manner that represents the whole extent or area of individual trapping sites can accommodate each of these scenarios. This may be as simple as taking single waypoints at small sites (which may represent 4–5 traps placed at a small logjam) or as involved as taking multiple waypoints to accurately determine the boundaries of a relatively larger trapping site. It may also entail taking additional waypoints as a single trapping site is fished out and traps are 'shifted' or moved down/up stream; field crews may decide to keep their generic site name, since its in close proximity. One additional waypoint may be sufficient such that we would be able to map out the entire extent of the trapping area.

The bottom line is that multiple waypoints are collected at each site to generally describe the extent of the area being trapped. If two waypoints are collected for a single trapping area, generally identifying the upper and lower portions of the site and a few traps are below or above these waypoints by 20–30 meters, this is fine. We are looking for a precision of under 50 meters in most cases although 100 meters may be the best we can do in large braided areas of the Unuk floodplain, without unduly creating chaos for field crews where the primary responsibilities are trapping large numbers of fish. Figures 1–3 illustrate the use of waypoints in delineating or 'outlining' the extent of trap sites (areas) with an acceptable level of precision. In these figures, the polygons representing the trap sites (areas) may appear to be arbitrarily drawn, considering that although the points fall inside, they do not provide all the corners. We should note that stream banks and islands present obvious boundaries for the delineation of smolt trapping areas in absence of other information, and will be evaluated using aerial photography during delineation in the office to map the site extent.

The collection of waypoints associated with individual trap sites (areas) should accompany trap data in field notebooks used by research staff. This would include recording the GPS Model/Make (Magellan 320, Garmin 12XL, Garmin 450, etc), assigned Unit letter (e.g., L, M, N, etc), the waypoint number, the GPS positional error (or accuracy), and a very brief description of what the individual waypoint represents (e.g., upper most river right or lowest point on river left, etc). If only one GPS unit model (Garmin 12XL, Magellan 320, etc) is used by a crew throughout the smolt trapping season, then it will be unnecessary to record this information daily; just make sure the relevant unit information is on the first page of each field notebook used. One additional piece of information to be recorded includes species and fish numbers. If this data is generally collected concurrent with checking trap lines, then it should be recorded in field notebooks. This information will accompany trap related records associated with the trap site (area), which field crews collect each day, such as number of traps placed, number of traps checked, number of fish, number of traps pulled, etc. **An example of the data collected during smolt trapping which captures all the relevant GPS data is provided in Table 1**. Note that if sites shift, field crews should take another waypoint on the day they are shifted or moved, which depicts the extension of the trapping area (site), and code this information in their field notebooks.

If traps are placed in areas where no site name is given (especially locations where only 1 or 2 traps are placed), specific comments should include a concise description of the general location (e.g., on small tributary to main channel approximately 250 m from the main channel or in beaver pond complex on west side of main channel approximately 400 m from the main river channel).

In general, observers should *always describe features as to right or left as if they were looking downstream (e.g., confluence right bank)*—in other words, "**going with the flow**".

Table 1.–Example of data collected and recorded in the field during smolt trapping efforts on the Unuk River in Fall, 2003.

Date: 10/20/2003 GPS Unit Model: Magellan 320, (unit L)

| Site | Traps checked | Traps pulled | Traps added | Total traps | # of fish by species | Way-point # | Waypoint Accuracy (m) | Waypoint description |
|---|---|---|---|---|---|---|---|---|
| Spruce Row | 5 | 2 | 0 | 3 | 30 coho; 10 king | 5,6 | 10; 10 | 5 – upper; 6 – lower |
| Moose Bar | 2 | 0 | 2 | 4 | 50 coho | 7,8 | 8, 12 | 7– upper; 8 – lower |
| Big Beaver | 3 | 3 | 0 | 0 | 5 coho | 9 | 13 | Center of trap area |
| Snowball | 0 | 0 | 3 | 3 | New sets | 10, 11 | 6, 9 | 10 – upper; 11 – lower |
| Total | 10 | 5 | 5 | 10 | 80 coho; 10 king | | | |

In summary, coordinate data should be recorded at all CWT trapping sites where minnow traps are deployed. As an alternative to recording GPS coordinates at each and every minnow trap being deployed, observers can define the bounds of the area being trapped (e.g., Spaghetti Flats, 6-pack slough). If a site is fairly confined or constrained (e.g. has a defined upper and lower end such as a slough) then 1–2 waypoints should be taken at the upper and lower extents of the upper portion and additional waypoints as necessary taken at the extents of the lower reach. Trapping observations recorded in 'smolt trapping data books' should include the saved waypoint number(s), and include vernacular name assigned to that particular site.

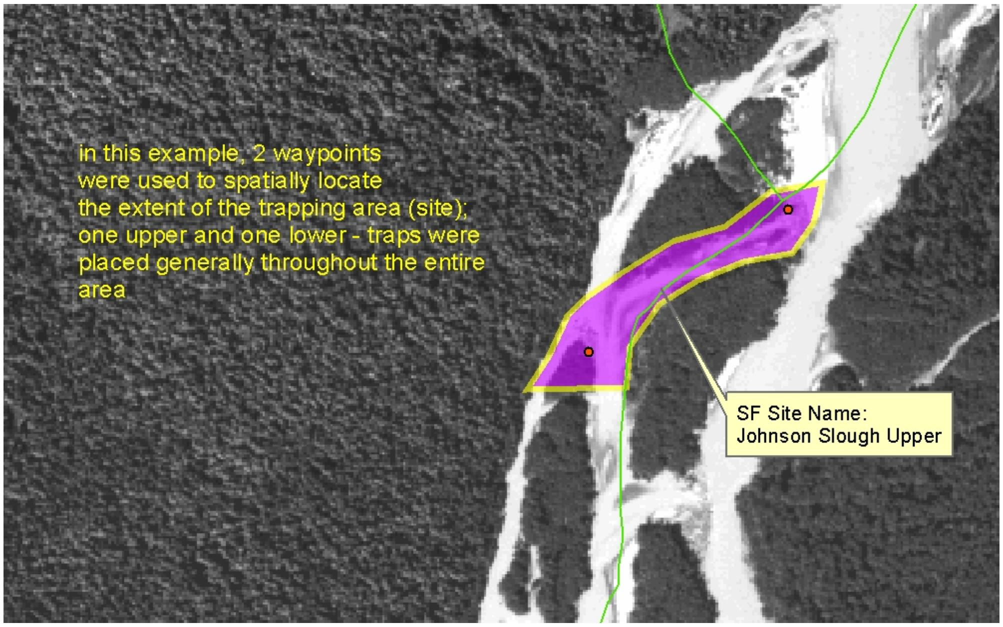


Figure 1.–Smolt trapping site on the Unuk River. The outlined polygon represents a single trapping site or area known as Johnson Slough Upper. Individual trapping sites may contain an infinite number of traps. The orange dots represent 2 waypoints collected to delineate the 'approximate' extent of trapping effort associated with this site.

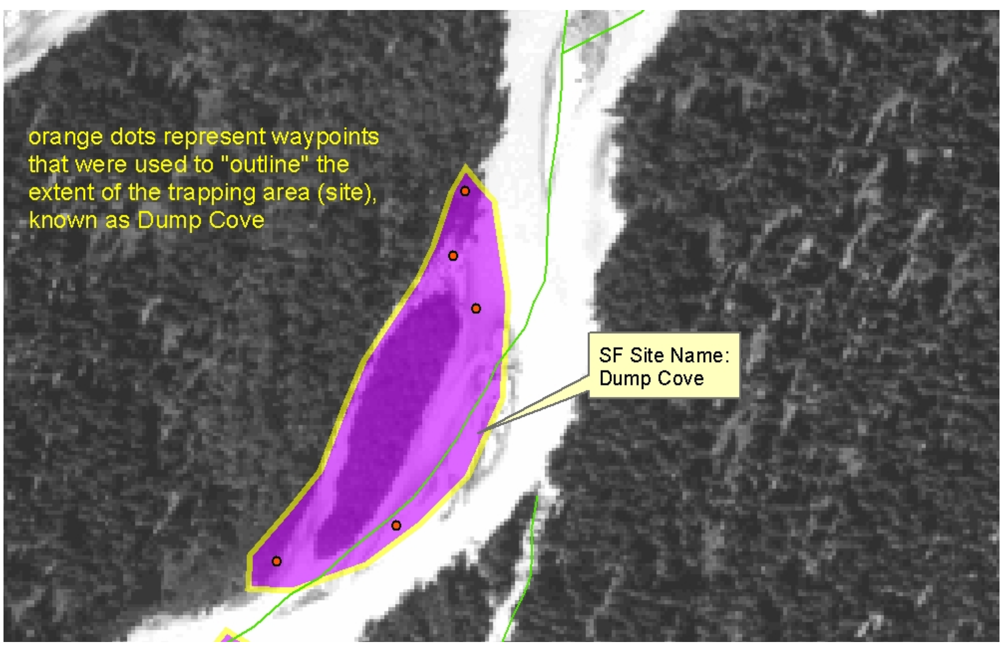


Figure 2.–Using more than two waypoints to delineate the extent of the trap site '*Dump Cove*' on the Unuk River. The upper and lower most waypoints are critical, although the 3 other points allow us to more accurately represent traps that were placed on the river left side of the island.

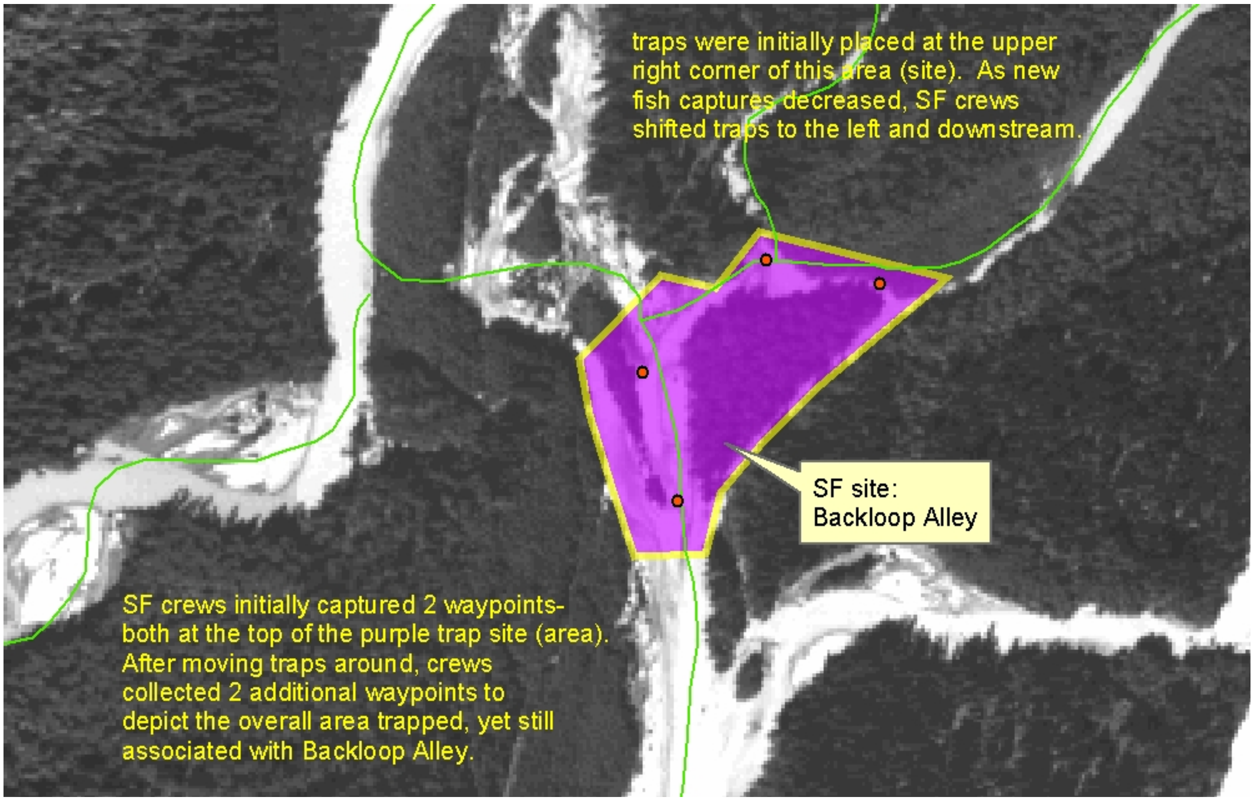


Figure 3.–Example of expanded trap site, and GPS locations used to document that site as local conditions changed due to changing trap catches, and rising and falling water conditions on the Unuk River, Alaska. Again, SF crews shifted traps in response to decreasing numbers associated with initial trap locations (upper portion of polygon). Rather than re-name the SF site, they elected to capture 2 more waypoints associated with new trap locations thereby providing 4 “corners”, where we could delineate the Backloop Alley trap site (area).